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The Status of *Eleutherodactylus pinarensis* and a New Species of the Genus from Western Cuba

By ALBERT SCHWARTZ

I have recently (Schwartz, 1959, Amer. Mus. Nov., 1926: 9-10) pointed out that the correct application of the name *Eleutherodactylus pinarensis* Dunn presents certain taxonomic problems. This species was described from the Isla de Pinos, and the type locality (Dunn, 1926, Occas. Papers, Boston Soc. Nat. Hist.: 213) was given merely as the "Isle of Pines." The type has more exact locality data than Dunn indicated, having been collected at Los Indios, on the western shore of the Isla, and which was one of G. A. Link's principal collecting localities on the Isla. At the time of description, Dunn had before him the type and forty-one specimens which may be regarded as paratypes. *E. pinarensis* was diagnosed as "a large species uniformly shagreened above; belly feebly rugose; disk of fingers III and IV developed; tympanum nearly as large as eye; color marbled dark and light; young crossbarred dark and light." Of the series available to Dunn, only the type is a large adult, showing the marbled light and dark coloration of the species; the paratypes are all small, some crossbarred and some not, and all were apparently regarded as juveniles. In addition, it is pertinent that the single adult *pinarensis* came from the Isla de Pinos, whereas the juveniles were from Pinar del Río Province with the exception of two from Habana Province.

Collecting in western Cuba has never yielded any large frogs comparable to the type of *pinarensis*. However, large lots of crossbarred and variously marked "juveniles" have been collected in Pinar del Río. On the Isla de Pinos, a long series of frogs, distinctly like the type of *pinarensis*, but somewhat larger, was taken; this species was also collected in Cuba in Habana and Matanzas. Neither on the Isla de Pinos, nor in Habana and Matanzas have crossbarred "juveniles" been taken; on the Isla two small *pinarensis* proved to be colored and patterned exactly like the adults. From these data it is apparent that Dunn had confused two apparently allopatric species under the name *pinarensis*, one large, robust and mottled, the other small, delicate and often crossbarred.

The large series of the new frog described herein has been made through the efforts of the following men; to each of whom I owe personal thanks for their assistance: John R. Feich, Armando García, William H. Gehrmann, Ronald F. Klinikowski, Dennis R. Paulson, Donald

R. Price and George R. Zug. The drawings are by Miss Sandra L. Bressler who has portrayed these frogs accurately. For the loan of pertinent material, I wish to thank the following curators for their generosity and courtesy: Charles M. Bogert, American Museum of Natural History (AMNH); Ernest E. Williams, Museum of Comparative Zoology (MCZ); Carlos G. Aguayo y de Castro and Isabel Pérez Farfante, Museo Poey (MP); Norman E. Hartweg, Museum of Zoology, University of Michigan (UMMZ); and Doris M. Cochran, United States National Museum (USNM). Recent collections have been made under the auspices of two National Science Foundation research grants.

I have been able to examine all paratypes of *pinarensis* with the exception of USNM 54399 and MCZ 3721, 4180, and 4190-94. Of the paratypes, USNM 59329-35 are *zugi* Schwartz and represent a second locality for this diminutive frog (San Diego de los Baños, Pinar del Río); MCZ 3048 and USNM 57862-63 are *ricordi planirostris*. These two specimens are those upon which the range of *pinarensis* had been previously said to include Habana Province. The remaining paratypes (UMMZ 92441; USNM 26651-52, 27860-61, 59348, 27417; MCZ 4176-79, 4181-89) are now all correctly assigned to the frog described below.

The new frog which has previously been confused with *pinarensis,* may be called, in recognition of the companionship, assistance, and interest displayed by Ronald F. Klinikowski in the field in Cuba;

Eleutherodactylus klinikowskii, new species

Type: AMNH 63120, from Mogote de Tumbadero, 1 km. E Viñales, Pinar del Río Province, Cuba, taken August 11, 1958, one of a series collected by Armando García, Albert Schwartz, and George R. Zug. Original number 6431.

Paratypes (from Pinar del Rio Province): 61885, 0.5 mi. S San Vicente, June 18, 1957, A. Schwartz; 61889, cliffs at Cueva del Río, San Vicente, June 23, 1957, W. H. Gehrmann, D. R. Paulson; 61890, mogote top at Cueva del Río, San Vicente, June 23, 1957, W. H. Gehrmann; 61891, cliffs at San Vicente, July 7, 1957, J. R. Feick and W. H. Gehrmann; 61907, cliffs at Cueva del Río, San Vicente, August 29, 1957, W. H. Gehrmann and A. Schwartz; 63048, cliffs at Cueva del Cable, San Vicente, August 17, 1958, A. Schwartz; 63050-59, 63061, 63064-67, 63069, 63071-74, 63077-79, 3.5 km. NE Guane, August 26, 1958, A. García, A. Schwartz, and G. R. Zug; 63104-05, 10 km. N Cabezas, Cueva de Santo Tomás, December 27, 1958, A. García, R. F. Klinikowski, and A. Schwartz; 63109, cliffs at San Vicente, December 25, 1958, R. F. Klinikowski, D. R. Price, and A. Schwartz; 63119, 0.5 mi. S San Vicente, December 30, 1958, A. Schwartz; 63136-37, same data as type.

Distribution: known from the Sierra de los Organos and the western section of the Sierra del Rosario, from the vicinity of Guane east to San Diego de los Baños, entirely within Pinar del Río Province, Cuba.

Diagnosis: A member of the *ricordi* group, distinguished by small size (adult females as large as 27 mm., adult males as large as 24 mm.), dorsal pattern usually, 60%, consisting of three anterior dark crossbars (including an interocular bar) on a light tan background, or with a uni-

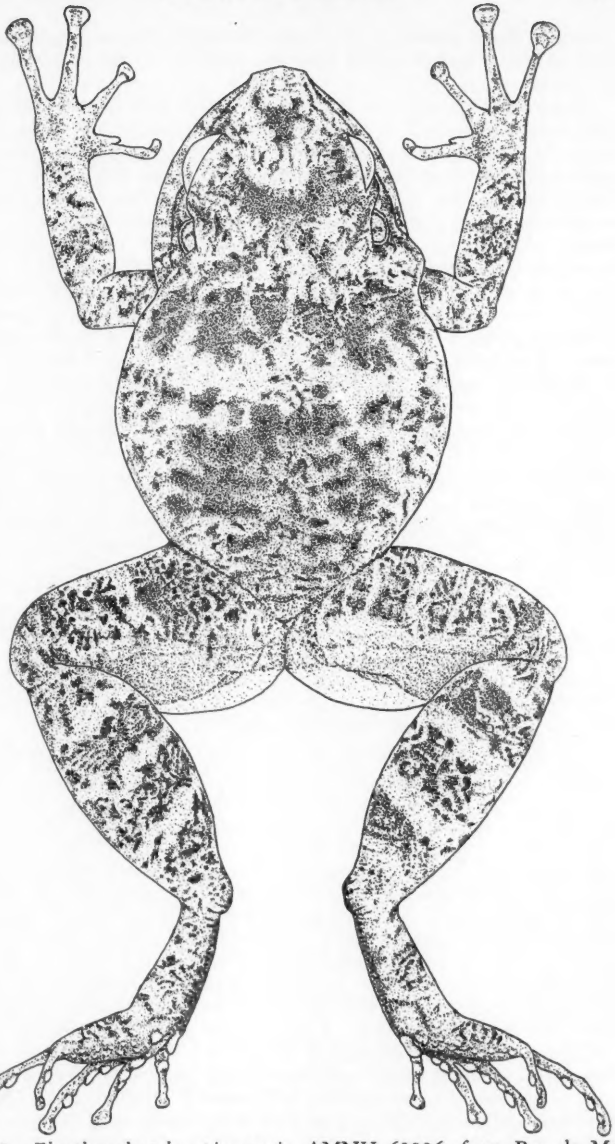

Fig. 1. *Eleutherodactylus pinarensis,* AMNH 63006, from Pan de Matanzas, 2.5 mi. S Corral Nuevo, Matanzas Prov., Cuba; s-v 58.2 mm.

color tan dorsal pattern with a dark interocular bar and a single dark chevron, or a median dorsal pale tan hairline, or any combination of the above.

Description of type: A gravid female, (in millimeters): snout-vent 21.9; head from snout to posterior border of tympanum, 8.0; width of head, 7.8; longitudinal diameter of eye, 2.9; longitudinal diameter of tympanum, 1.8; naris to eye, 2.5; femur, 9.3; tibia, 9.9; fourth toe, 8.9. Head about as long as broad; snout distinctly acuminate with nares inconspicuous at anterior end of canthus rostralis; diameter of eye slightly longer than distance from naris to anterior corner of eye; interorbital space 2.8, equal to diameter of eye; diameter of tympanum distinctly less than diameter of eye, distance from tympanum to eye equal to about one third diameter of tympanum. Digital discs present, moderately sized and prominent, that of digit 3 the largest and equal to about one-half the size of tympanum. Fingers relatively short, unwebbed, 3-2-4-1 in order of decreasing length; subarticular tubercles moderately developed, pigmented with melanophores. Toes moderate in length, unwebbed, 4-3-5-2-1 in order of decreasing length; subarticular tubercles moderately developed, overlaid by melanophores. Heels barely overlap when legs are held with femora at right angles to body axis. Dorsum covered by low, flattened granules. Throat and chest smooth; belly strongly granular. Posterior surface of thighs covered with smooth, flattened, pavement-like granules. No supra-axillary, inguinal, or femoral glandular areas. Belly disc well developed with a prominent fold between axillae and another fold anterior to hind limbs. Tongue small, oval, entire posteriorly and free, its greatest width about equal to one third that of the floor of the mouth. Vomerine teeth in two rather long, slighly bowed series, situated well behind the choanae; the lateral ends of the vomerine tooth rows separated from the posterior edge of choanae by about half the diameter of a choana, and their medial ends separated from each other by a distance equal to half the diameter of the choanae.

Coloration of type (based on field notes from life): Ground color anteriorly pale pinkish tan (Pl. 11, C5; all color designations from Maerz and Paul, 1950, A Dictionary of Color, 208 pp.), becoming less pinkish (Pl. 10, D4) posteriorly. Snout pinkish tan, like dorsum. Venter cream colored and translucent. Hind limbs tan (Pl. 11, C8), their concealed surfaces unicolor with dorsal exposed surfaces. All dark markings brown (fig. 2, left). The dark markings consist of an interocular bar, not reaching edge of upper eyelids, which extends posteriorly in the form of a triangle confluent with a second (nuchal) transverse bar, which in turn is connected centrally to a third (supra-axillary) transverse bar, the second and third bars extending laterally, but not fusing with a canthal stripe which extends from the snout to the anterior corner of eye, then coninues poserior from the posterior corner of eye to above the insertion of fore limb. Posterior to the supra-axillary bar, there is a series of five or six transverse bars, becoming increasingly less intense posteriorly; thus the effect is of a completely transversely barred dorsum. The dorsal surfaces of both fore and hind limbs are stippled with brown, but the concealed surfaces of the hind limbs are unmarked. The ventral surfaces are stippled with dark brown, with the exception of the center of the abdomen.

Variation: The measurements of the 15 largest males are: snout-vent

21.0 (18.9-24.2); head length, 8.4 (7.4-9.6); head width, 8.5 (7.7-9.6); diameter of eye, 3.0 (2.6-3.4); diameter of tympanum, 2.2 (1.9-2.4); naris to eye, 2.4 (2.0-2.9); femur, 9.5 (8.6-11.3); tibia, 10.3 (9.4-12.3); fourth toe, 8.8 (8.0-10.4). The 25 largest females measure: snout-vent, 23.2 (20.4-26.7); head length, 8.8 (8.0-9.8); head width, 8.9 (7.8-10.7); diameter of eye, 3.0 (2.4-3.5); diameter of tympanum, 1.9 (1.6-2.1); naris to eye, 2.8 (2.2-3.3); femur, 10.2 (9.3-11.4); tibia, 11.1 (9.9-12.7); fourth toe, 9.6 (8.6-11.1). The principal differences between the sexes are the slightly greater size of the females (although this is not so striking as in some other Cuban *Eleutherodactylus*) and the smaller tympanum in the females. In structure these adults agree well with the type, except, for a distinct amount of variation in the degree of dorsal granulation. The type lies near the lower extreme in this character. Of the 25 largest females, 12 are gravid; these range snout-vent from 20.4 to 23.8. One smaller female (AMNH 63139), snout-vent 18.2, is also gravid. Apparently this species matures at a relatively small size. The peritoneal covering of the testes is jet black, and that of the ovaries usually bears melanophores, although the entire ovary is never solid black.

The variation in pattern of *klinikowskii* is extreme and confusing; in my early collections from Pinar del Río there were but few adults and a large lot of tiny juveniles, many of which lacked the transverse banding as described for the type. With the accumulation in 1958 of a large series of breeding adults, as well as juveniles, from a restricted locality, the situation was clarified, and the assortment of patterns can be classified into three major types.

Type 1. As described for the type. The pattern is principally of transverse bars, with usually the anteriormost three (interocular, nuchal, and supra-axillary) the most prominent, on a tan to pinkish ground color. In some specimens there is a pale pinkish median hair line, extending from the interorbital area posteriorly to above the vent, where it divides, sending a branch along the posterior side of the thigh to end behind the knee. The dark crossbars may be prominent over the entire dorsum (AMNH 63119), and number as many as ten, and may even be so extensive and fused as to give the frog an almost entirely dark back (AMNH 63051), with only the pale interspaces indicated as pink blotches anteriorly. In those specimens which are heavily pigmented dorsally, there is an accompanying heavy stippling ventrally. One specimen (AMNH 61907) has only the barest vestiges of the barred pattern, and is almost a brown mottled frog. The crossbarred frogs comprise 60% of the sample of 150 frogs examined.

Type 2. The dorsum is either uniformly brown with a darker interocular bar, or is stippled with brown on a tan ground color, with only remnants of the nuchal and supra-axillary transverse bands (fig. 2, center). The interocular bar in all cases is present. There is no median hair line. This pattern comprises 24% of the specimens.

Type 3. The dorsum is less heavily stippled with brown, but is in general of a darker (tan) ground color. A median hair line, forking over the vent and extending over the thighs to behind the knee, is always present. In addition, a pair of dorsolateral stripes is often present (fig.

2, right). The interocular bar is well marked, but usually only one transverse bar, the supra-axillary, is present as a dorsal chevron, its apex directed anteriorly. The nuchal bar may be indicated by a few scattered dark dots or mottlings, but is never prominent. Sixteen percent of the sample shows this pattern. One (AMNH 63127), assigned to this pattern type, is similar to specimens of *zugi* which show the dorsolateral stripes (Schwartz, 1958), Jour. Wash. Acad. Sci., 48(4): 127-31). That it is not a specimen of *zugi* is demonstrated by the lack of rosy suffusion on the thighs in life and absence of a brown band across the center of the thigh.

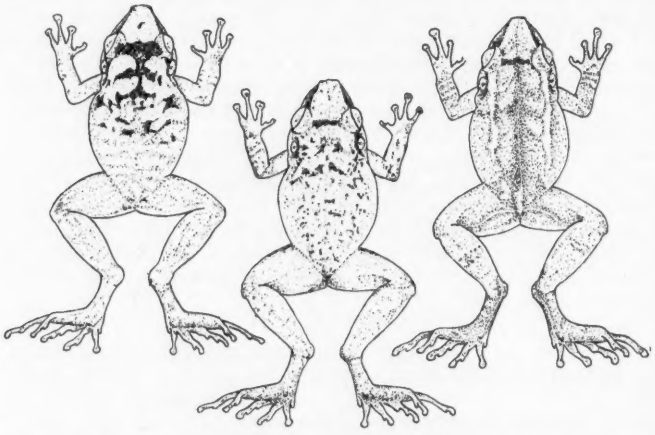

Fig. 2. (Left) *E. klinikowskii,* new species, AMNH 63120, type, s-v 21.9 mm., illustrating pattern type 1. (Center) *E. klinikowskii,* AMNH 63057, paratype, s-v 22.6 mm., illustrating pattern type 2. (Right) *E. klinikowskii,* AMNH 63137, paratype, s-v 22.6 mm., illustrating pattern type 3.

Although I have categorized the three types of pattern as though they were discrete units, intergradation exists. It is because of the intergradation of patterns that this highly variable assemblage was ultimately considered to represent a single species.

The coloration of the dorsum varies from pinkish tan to light yellow and yellowish tan to almost orange; the dark markings vary from brown to rich dark purple. Usually the arms are a bit more brightly colored than the dorsum. The concealed and dorsal surfaces of the hind limbs are usually tan, but in one they were recorded as gray.

Comparisons: *E. klinikowskii* is a member of the *ricordi* group as defined by Dunn, by virtue of possessing long vomerine tooth series, rugose

dorsum, rugose belly and digital discs restricted to the outer two fingers, although present, but less well developed on the inner two. To this group are at present assigned twelve species. Comparison of the new species with the larger members of the group is unnecessary; *pinarensis, greyi, brevipalmatus, sierramaestrae,* and *turquinensis* all reach a much larger size (female *pinarensis* reach 62 mm. in snout-vent, males 54.4), and with none of these is *klinikowskii* known to be sympatric. Detailed comparisons with *pinarensis* are unnecessary, despite the previous confusion of the new species with this form. As illustrated (fig. 1), *pinarensis* presents a pattern of dark gray, black, or brown mottling on a light gray ground color; there is an irregular interocular bar and a pair of irregular scapular blotches, often confluent medially. These are followed by additional prominent mottling. The hind limbs are banded, especially on the tibiae. There is a group of warts at the angle of the jaws. In all these features, *pinarensis* differs from the new species; as noted above, two juvenile *pinarensis* (AMNH 63014, 63042, snout-vent respectively 20.0 and 23.7) are patterned and colored like adults and show no resemblance to the crossbarred pattern of *klinikowskii.*

From the species *atkinsi, gundlachi,* and *zugi, klinikowskii* differs in lacking red on the hind limbs and in the groin. In addition, *klinikowskii* is larger than *zugi* (in which species the females reach a maximum known size of 19 mm.), smaller than *atkinsi,* and equal in size to *gundlachi. E. klinikowskii* is known to be sympatric with *zugi* (San Diego de los Baños), is not sympatric with *gundlachi* (which is known only from Oriente), but is presumed to be sympatric with *atkinsi,* although the two have not been taken at precisely the same locality. From both *zugi* and *gundlachi, klinikowskii* differs in lacking markings on the legs, and from *atkinsi* in the absence of black groin markings.

Both *cuneatus* and *thomasi* have distinct glandular areas in the groin and above the forelimb insertion and both are larger than *klinikowskii.* The new species is sympatric with *cuneatus* and although these two species have different ecological requirements (*cuneatus* is riparian, *klinikowskii* is petricolous), they have been taken together. The W-shaped scapular fold of *cuneatus,* larger size, and distinctly different patterns differentiate the two. *E. thomasi* is not known to occur with *klinikowskii;* these two species differ both in size and pattern.

Compared with *etheridgei,* the new species is larger; in addition, *etheridgei* is not known to have the crossbarred pattern of *klinikowskii.* However, there is some resemblance between the pattern of *etheridgei* and that of type 2 of *klinikowskii,* although the former has a single bold interbrachial dark bar, rather than a pair of chevrons on the dorsum. The two species are not sympatric.

From *ricordi, klinikowskii* differs in apparently lacking the patterns which typify the former; *ricordi* is the larger. These two are sympatric and are occasionally taken in the same habitat, although *ricordi planirostris* is not exclusively a petricolous form.

In summary, *klinikowskii* differs from all known Cuban members of the *ricordi* group especially in its distinctive crossbarred dorsal pattern. The other two pattern types may be confused with *zugi* or with *etherid-*

gei, but the characteristics mentioned above will serve to distinguish all specimens.

Remarks: *E. klinikowskii* inhabits the Sierra de los Organos and the western section of the Sierra del Rosario. It is restricted to rocky areas, such as clig faces, talus slopes, mouths of large caves and interiors of smaller caves. It is a climber, at least on rocky faces, and on rainy afternoons and nights it is often the most common member of the genus abroad in certain areas. The males vocalize from solution holes, crevices and other irregularities in the rock face. Two specimens have been taken on the leaves of trees or shrubs five feet above the ground; in both cases, the plants were close to cliff faces. *E. klinikowskii* is rather shy at night, but extremely wary during the day, retreating quickly into the crevices in which it apparently spends the day when the climatic conditions are unfavorable. At a small cave near Guane, these frogs were active during the day in the interior of the cave seeking refuge in the carpet of dead leaves which had blown into the cave. At this particular locality they were especially abundant.

At the type locality, Mogote de Tumbadero, a series of 29 adults and juveniles was collected August 11, 1958. The frogs were abundant at the foot of the cliff of the *mogote* during a heavy afternoon shower and were vocalizing during the day. Here they were associated with *eileenae, cuneatus, r. planirostris,* and *a. olibrus,* but were the most common species present. At Cueva de Santo Tomás, *klinikowskii* was collected while calling on December 27, 1958. The frogs were found both at the entrance of the cave and in great abundance in the first *olla.* Here they were associated with *d. amelasma, cuneatus, eileenae, a. olibrus,* and *r. planirostris.* Both *zeus* and *symingtoni* occur in the *olla,* but have not been collected in the same habitat as *klinikowskii.*

Although I have noted above that *pinarensis* occurs in Cuba only in Habana and Matanzas provinces, it may be noted here that a single, much faded subadult female (MP 77) *Eleutherodactylus* has been studied. This frog was apparently given to the Museo Poey by the Museum of Comparative Zoology, and thus may well have been available to Dunn (although not specifically noted by him) at the time of his review of the Cuban members of the genus. The specimen is from Valle San Juan, Península de Guanahacabibes, Pinar del Río Province. Valle San Juan lies about 13 kilometers west of Cayuco, and thus in some of the most inaccessible area in western Cuba. George Zug and I attempted to reach this locality by jeep in August, 1958, but because of very heavy rains the primitive road was almost impassable, and we were only able to reach a locality called Vallecito de San Juan, approximately 11 kilometers west of Cayuco, and within 2 kilometers of whence this frog was collected. No *Eleutherodactylus* comparable to this old large specimen were taken, and thus the status of this apparently isolated population remains uncertain. The Museo Poey specimen agrees in all structural characters with my concept of *pinarensis,* but the coloration and pattern are so faded as to render any assignment uncertain. If this frog is *pinarensis,* it represents the only record from Pinar del Río, in an isolated and remote region.

Specimens examined (all from Pinar del Río Province, Cuba, and all from the AMNH unless otherwise indicated): 63049-80, 3.5 mi. NE Guane; USNM 27417, El Guamá; MCZ 4176-49, 4181-89, Luis Lazo; MP, Potrerito, Sumidero; 63081-85, 9.1 mi. SW Sumidero; 61886, 63086-108, Cueva de Santo Tomás, 10 km. N Cabezas; 63046-47, north base, Pan de Azúcar, 8 km. E Matahambre; MP, Viñales (3 specimens); 63120-42, Mogote de Tumbadero, 1 km. E Viñales (29 specimens); 59864, San Vicente; 59865, small cave just S San Vicente; 61885, 63119, 0.5 mi. S San Vicente; 61887-89, 61895-919, cliffs at Cueva del Río, San Vicente; 61890, mogote top at Cueva del Río, San Vicente; 61891-94, 63109-18, cliffs at San Vicente; 53048, cliffs at Cueva del Cable, San Vicente; USNM 26651-52, 27860-61, 59348, UMMZ 92441, San Diego de los Baños.

DEPT. BIOLOGY, ALBRIGHT COLLEGE, READING, PENNA.

RECORD SIZE DESERT TORTOISES.—The San Diego Zoo is the recipient of reptiles of various kinds that have become unwanted pets. Chief among such donations is the desert tortoise, *Gopherus agassizi*. During the past 27 years hundreds have been given to us. Some donors claim to have had them for 30 years or more.

Two exceptionally large tortoises have exceeded the maximum dimensions reported by Pope (1939, Turtles of the United States and Canada) and Carr (1952, Handbook of Turtles). Both tortoises greatly exceed the maximum weights reported for 30 adult males and 30 adult females by Chapman Grant (1936, Zoologica, 21 (4):226).

All measurements given are straight line. Carapace length was measured from the anterior edge of the nuchal shield to the supracaudal shield; plastron length from the anterior edge of the gular shield to the posterior point of one of the anal shields; width at the widest part of the carapace, slightly forward of midbody. Sex was determined from plastral shape as well as tail length.

The first tortoise of note, a male, was received May 29, 1953, from Mr. Tom Erbe of La Mesa, California. Mr. Erbe stated that he had found the tortoise on a street in East San Diego. Measurements and weight are given in centimeters and grams: carapace length 35.9; carapace width 27.3, plastron length 35.0, weight 8820.

The most recent exceptional specimen, a female, was donated to the Zoo January 10, 1959, by Mr. William Flemming of Pomona, California. Measurements and weight of this tortoise are: carapace length 36.9, carapace width 25.9, plastron length 37.2, weight 8600.—*Charles E. Shaw, Zoological Society of San Diego, San Diego 12, California.*

ERRATUM—Vol. 15, pt. 1, pg. 35, line 13, should read: "The eggs were unpigmented, adherent and without stalks. Following . . ."

OBSERVATIONS ON BEHAVIOR IN TWO LIBYAN SPECIES OF VIPERINE SNAKES

By HANS SCHNURRENBERGER

Two years spent in the Libyan desert provided an opportunity to observe the Avicenna viper, *Aspis vipera,* and the Horned viper, *A. cerastes,* under natural conditions. The two species do not seem to occur together although their general ranges are similar. Where *cerastes* was abundant *vipera* was never found and where *vipera* was abundant *cerastes* was rare.

My observations were made in 5 areas. One area is in Cyrenaica (the northeastern province of Libya), on the route from Soluch through Sceleidima, Bir Hag Hamed, Bir el Duéma, Bir Ben Ganía, Wadi el Mra, and Hatiet el Rtém. In this area only *cerastes* were seen. A second area, which I worked intensively for over a year, is in northwestern Cyrenaica north of the line Marble Arch-Bu Gréa-Maaten Giófer-Bir es Suéra-Mersa el Brega (see Fig. 1), where both species occur abundantly in largely segregated areas. Thirdly, in northwestern Tripolitania, where, in Wadi Sharghi (30 mi. E. Tripoli) and at distances of not over 1 mi. from the road exclusively *vipera* were seen. Fourth, in eastern Tripolitania, east 12° 45′ north 32° 15′, near Bir el Gnehm, where one *cerastes* was taken. Finally, in the province of Fezzan, of southern Libya, in Wadi Ilachlachan, 12 mi. s Serdeles, where two *cerastes* were observed.

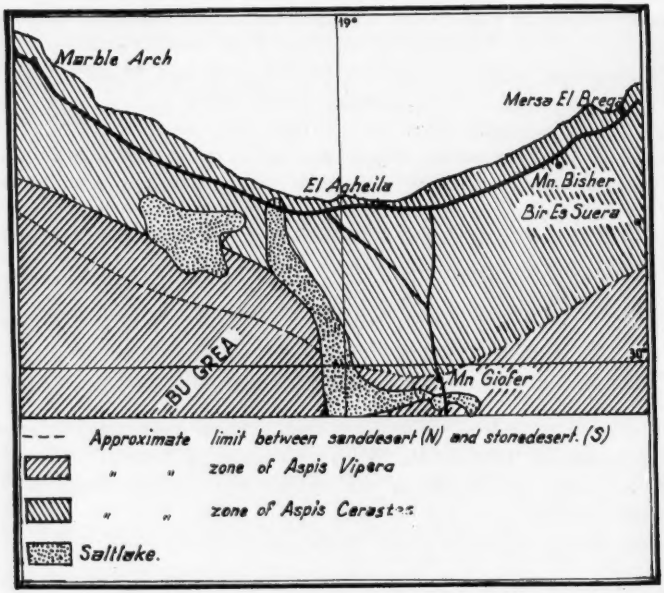

Fig. 1. Map of northeastern Cyrenaica, showing habitats and general local range of *Aspis cerastes* and *A. vipera.*

During a night's survey in August near Wadi Sharghi the activities of *vipera* were traced and can be summarized as follows. At about 8:00 p.m. the vipers left their hiding places in shallow, enlarged lizard-holes in sandhills or under bushes and started wandering about at air temperatures of 65°-70° F. They alternately crawled and buried themselves in the sand until about 1:00 a.m., when they burrowed until covered by about ½ inch of sand. Thus ensconsed they were in sand much warmer than the air at 50°-55° F. After 4:00 a.m. some started crawling again, and activity continued until about 6:00 a.m. Thereafter all stayed in their hiding-places, where only the snout is visible, or two small holes in the sand are present above the nostrils.

Both vipers are largely nocturnal. Rarely are they seen exposed to the sun except in late fall, in winter and in early spring. At other times they retreat to their hiding-places before sunrise. As a rule they are exposed only when the air is most humid; surprisingly the air humidity in most areas of the Libyan desert approaches or even exceeds 90% at sunrise, and in rodent holes even during the day air humidity remains high. Restriction of activity to times when moisture-loss is at a minimum is reasonable since the only source of water for the snakes is their food.

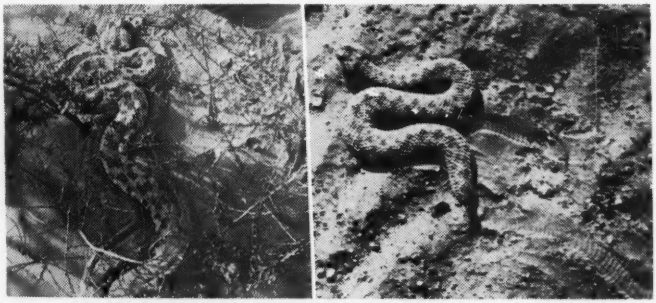

Fig. 2. (Left) *Aspis cerastes,* typical resting position near rodent hole. (Right) *Aspis vipera,* sidewinding.

Specimens of both species move miles during their hours of nocturnal and crepuscular activity.

An increase in activity in *vipera,* indicated by tracks, was observed in late March. The nights of March 31 to April 4 were spent entirely in the open, resulting in discovery of 3 copulating pairs, in every case hidden under the sand. Most specimens of *vipera* were found separated by several miles, but the three pairs were found in a small depression about 1500 ft. in diameter where according to traces at least 10 other pairs were present. In captivity one pair remained in copulation 4 days.

Hibernation takes place from January to February, but is frequently interrupted on warm days. Snakes can be found even in winter under stones, in holes, etc.

Mertens (1953, Natur. Volk, 83: 148-156) has already described in

detail the peculiar locomotion of these vipers. The tracks of *vipera* seem more angular than those of *cerastes*.

Sexual dimorphism is evident in *vipera*, in which the tail tip is black in females, sand-colored and lighter than rest of body in males. In the mating pairs the females were larger than their mates.

Color variation in *cerastes* considerably exceeds that of *vipera*. Many *cerastes* have brown and blue spots whereas *vipera* mostly varies only between dark and light brown in spotting on a uniform sand-colored ground. A few rustbrown specimens of *vipera* are found; all those at Wadi Sharghi were so colored.

My long stay in northwestern Cyrenaica enabled me to contrast the habits of both species simultaneously. The northern part of this zone, to about 12 miles from the coast, consists of sandy desert with sparse vegetation, where the proportion of *vipera* to *cerastes* was 15:1. In the stone desert to the south I found no *vipera*. Curiously, in this whole area the *cerastes* possessed no horns or small ones, whereas in eastern Cyrenaica they possessed long horns.

Contrasts in 5 behavioral attributes are as follows. *Habitat: cerastes,* stone- and sand-desert with some vegetation, mostly in stony areas, but avoiding coarse sand; *vipera,* exclusively sand-desert with more or less vegetation, mostly without small stones or just dotted with them, preferably silty sand. *Hiding-places: cerastes,* rodent-holes or under stones; *vipera,* sandhills grown with bushes. *Resting positions away from hiding places: cerastes,* slightly covered with sand or on surface of it, also between stones, mostly close to hiding place; *vipera,* completely covered with sand. *Behavior when disturbed: cerastes,* disappears in shelter or does not move at all; *vipera,* if on surface, burrows self immediately in sand to withdraw from view of enemy. *Food: cerastes,* rodents, birds, geckos, agamas, chameleons and other lizards, apparently rejecting skinks; *vipera,* small lizards.

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ARIZONA ELEGANS IN SOUTHEASTERN TEXAS.—During the past three years I have made several trips to various localities in southern Texas. During these trips 29 *Arizona elegans arizonae* have been taken DOR or AOR. Most of them have been reported on in the literature.

The most recent specimen constitutes a south-eastern extension of range for the genus. A young male, was collected as it crossed Texas State Highway 6, three miles north of Hemstead, Waller County, September 8, 1958, about 7:30 P.M. This record extends the known range 70 miles south and 25 miles east of Robertson County, a locality well within the Lufkin Sand formation, which extends from the central coast region into southeastern Texas.

It differs from 86 other *A. elegans* that I have examined from southern Texas in having only 27 scale rows at mid-body. About 90 percent from the eastern parts of the state have 31 rows at mid-body, 29 in the remaining 10 percent. The other scale characters fall within the range of variation for the subspecies *arizonae.*—*James R. Dixon, Department Wildlife Management, A. & M. College of Texas, College Station, Texas.*

FOODS OF SOME KENTUCKY HERPTILES

By FRANCIS M. BUSH

A herpetofauna survey was conducted during the summers of 1955 and 1956. Food items were determined from stomach contents. These are of ecological interest because they show the variability in the herptile diet.

The study plot, Clemons Fork, was approximately 11 airline miles southwest of Jackson, Breathitt Co., Kentucky, and 13 airline miles northwest of Hazard, Perry Co., Kentucky.

Stomach contents were emptied into white enameled pans containing water where the various insect parts were easily separable. A stereoscopic binocular microscope was employed in the determination of small organisms.

I am indebted to P. W. Oman and co-workers, U. S. Department of Agriculture, Insect Identification and Parasite Introduction Section, Beltsville, Md., for their valuable assistance in the identification of insects.

Bufo terrestris americanus Holbrook

A variety of beetles (44.3% by volume) and ants constituted the bulk of the diet (Table 1). Fragments of millipedes, spiders, worms, and grasshoppers were abundant in a few. Garman (1901) listed ants, beetles and bugs in order of occurrence. Miller (1909) found five beetle familes, ants and crickets. Hamilton (1930, 1954) noted that immature toads consumed Diptera 22%, mites 15.5% and ants 15.5% by volume; adult toads fed on beetles 34%, ants 18.5% and Lepidoptera 15.1% by volume. Larson (1943) reported blister beetles as the main food item, listing nine orders and 33 insect families. Barbour (1953) mentioned beetles 70%, millipedes 16.2% and snails 10.4% by volume.

Table 1. Stomach contents of 15 *Bufo t. americanus*

Food Items	Volume (%)	Frequency (%)
COLEOPTERA		
Carabidae	33.3	73.3
Scarabaeidae	11.1	20.0
Chrysomelidae	5.4	20.0
Lucanidae	2.1	20.0
Elateridae	1.3	13.3
Curculionidae	1.1	13.3
HYMENOPTERA		
Formicidae	16.2	26.6
ORTHOPTERA		
Acrididae	6.7	26.6
Gryllidae	.1	6.6
DIPLOPODA	4.7	6.6
HEMIPTERA		
Reduviidae	3.3	13.3
PULMONATA		
Zonitidae	2.1	13.3

ARACHNIDA	2.1	6.6
OLIGOCHAETA		
Lumbricidae	.1	6.6
Unidentified	.1	6.6
Sand, rock, gravel	3.1	30.1
Unidentified, leaves	4.5	

Bufo woodhousei fowleri (Hinckley)

The food of this species (Table 2) differed little from those of the American Toad. Beetles were more prevalent (61.3% by volume); carabids constituting over half the total volume. Body parts of spiders and harvestmen were found in three. Barbour (1953) reported beetles 67.4%, millipedes 14.4% and ants 13.7% by volume.

Table 2. Stomach contents of 18 *Bufo w. fowleri.*

Food Item	Volume (%)	Frequency (%)
COLEOPTERA		
Carabidae	50.1	88.8
Chrysomelidae	3.5	16.6
Lucanidae	3.5	5.5
Elateridae	2.8	11.1
Scarabaeidae	1.4	5.5
HYMENOPTERA		
Formicidae	20.8	33.3
ORTHOPTERA		
Acrididae	9.3	22.2
Rhaphidophoridae	.5	5.5
HEMIPTERA		
Reduviidae	2.0	5.5
Gelasticoridae	1.1	5.5
ARACHNIDA	.5	5.5
Sand, rock, gravel	4.1	27.6
Unidentified, leaves	.4	

Rana catesbeiana Shaw

Crayfish were the most common recoverable constituents (Table 3). Some caterpillars, fireflies, and centipedes were also found. Frost (1935) reported snails, amphibians, sparrows, beetles, grasshoppers, moths, cicadas and immature *Sternotherus odoratus*. Cohen and Howard (1958) found 32 major foods, listing Coleoptera 43%, spiders 16.3%, and Notonectidae 10.3% in greatest frequency.

Table 3. Stomach contents of 18 *Rana catesbeiana*

Food Item	Volume (%)	Frequency (%)
DECAPODA		
Astacidae	47.7	50.0
LEPIDOPTERA	19.0	11.1
COLEOPTERA		
Lampryidae	5.8	5.5
Chrysomelidae	5.8	5.5
Carabidae	4.1	11.1
Curculionidae	.3	5.5

PULMONATA		
Zonitidae	8.3	16.6
CHILOPODA	7.7	11.1
Sand, rock, gravel	1.2	5.5
Unidentified	.1	

Rana clamitans melanota Latreille.

The diet of the Green Frog was more diversified than any other amphibian (Table 4). Beetles made up 40.4%; snails and slugs 35.1% by volume. Garman (1901) mentioned some whirligig beetles, *Gyrinus*. Hamilton (1948) listed 21 kinds of major foods, and found beetles comprised 21.5%, Diptera 17.7%, Orthoptera 12.8%, caterpillars 11.8% by bulk. Barbour (1953) reported: Lepidoptera 33%, beetles 22% and *Cambarus* 15% by volume.

Table 4. Stomach contents of 20 *Rana c. melanota*

Food Items	Volume (%)	Frequency (%)
COLEOPTERA		
Carabidae	20.6	35.0
Brentidae	5.1	5.0
Coccinellidae	5.1	5.0
Cerambycidae	3.9	5.0
Platypodidae	2.8	10.0
Scarabaeidae	1.8	20.0
Elateridae	1.1	5.0
PULMONATA		
Zonitidae	30.0	20.0
Unidentified	5.1	5.0
LEPIDOPTERA	5.1	10.0
HEMIPTERA	3.9	5.0
DECAPODA		
Astacidae	3.4	10.0
CHILOPODA	2.2	5.0
OLIGOCHAETA		
Lumbricidae	1.1	5.0
HYMENOPTERA		
Formicidae	.5	5.0
Sand, rock, gravel	4.4	10.0
Unidentified, leaves	3.9	

Chelydra serpentina serpentina Linnaeus.

The food of three specimens was essentially the same. *Cambarus* sp. 75% and *Hyla v. versicolor* 25% by volume. Babcock (1916) noted that a large male consumed marsh grass, *Distichlis spicata*. Pell (1940) found 80.2% plant material and 16.2% animals (snails, clams, crayfish, insects, fish and frogs). Carr (1952) listed vegetable matter 36.2%, fish 35.4%, and carrion 19.6% by volume.

Terrapene carolina carolina Linnaeus.

Numerous snails and slugs (52.5% by volume) comprised the greater portion of the diet of ten specimens. Masses of mushrooms 10%,

several caterpillars 10%, carabids 4% and centipedes 3.5% by volume formed a fraction. Surface (from Carr, 1952) reported 80% animal and 62% vegetable. Creaser (1940) found non-toxic mushrooms in one. Barbour (1950) noted snails 60%, *Cambarus* 15% and plant material 12.5% by volume.

Natrix sipedon sipedon (Linnaeus).

Seven had: Cyprinidae 42.8%, Centrarchidae 28.5%, *Rana c. melanota* 14.3% and *Eurycea b. rivicola* 14.3% by volume. Schmidt and Davis (1941) reported fish 61%, frogs and toads 22% and salamanders 13% by volume. Barbour (1950) found fish 50%, *Rana* tadpole 12.5% and *Cambarus* 12.5% by volume. Brown (1958) listed 68% fish and 32% amphibian by volume.

Diadophis punctatus edwardsi Merrem.

Analysis of five Ring-necked Snakes: *Plethodon g. glutinosus* 40%, *Eurycea b. rivicola* 20%, *Desmognathus f. welteri* 20% and *Lygosoma laterale* 20% by bulk. Barbour (1950) reported *P. g. glutinosus* 21% *D. fuscus* adults 16% and larvae 14% by volume. Hamilton and Pollack (1956) found *Lygosoma* and *P. glutinosus* in two males. Wright and Wright (1957) mentioned insects, earthworms, toads, frogs, salamanders, snakes and lizards.

Carphophis amoenus amoenus Say.

Ten worm snakes contained only earthworms. Schmidt and Davis (1941) reported that "the diet apparently consists entirely or almost entirely of earthworms." Barbour (1950) mentioned ten having earthworms. Hamilton (1956) found earthworms in two. Wright and Wright (1957) also listed slugs and snails.

Opheodrys aestivus Linnaeus.

Examination of three: Arachnida (spiders and harvestment) 33%, Lepidoptera (larvae) 33%, Acrididae (subadults and imagoes) 33% by volume. Van Hyning (1932) found insects (mostly caterpillars) 53%, spiders 35% and frogs 12% by bulk. Hamilton (1956) stated that "the rough green snake is essentially an insect feeder," listing some 88.7% by volume. Wright and Wright (1957) reported insects, spiders, snails and frogs. Carpenter (1958) mentioned a large female containing a grasshopper.

Ancistrodon contortrix mokeson (Daudin).

The main food items from six were: *Peromyscus leucopus* 58.3%, *Pitymys pinetorum* 16.6%, *Lygosoma laterale* 16.5% and caterpillars 8.3% by bulk. Schmidt and Davis (1941) mentioned mice, shrews, and insects. Barbour (1950) found remains of *Napaeozapus, Sorex* and sphingid moth larva. Wright and Wright (1957) reported principally rodents and insects. Carpenter (1958) noted two cicadas and a spider in one stomach.

Crotalus horridus horridus Linnaeus.

The contents of three: *Peromyscus leucopus* 80%, *Sciurus carolinensis* 10% and songbirds 10% by volume. Barbour (1950) listed *Clethrionomys g. maurus* 50%, *Tamias s. striatus* 37.5%, *Peromyscus m. nubiterrae* 12.5%, *Napaeozapus i. roanensis* 12.5% and snails 12.5% by frequency of occurrence. Wright and Wright (1957) listed mammals and some birds

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Notes on the Natural History of *Rana muscosa* Camp in the San Bernardino Mountains

By DON P. MULLALLY

Previous to 1955 only limited information was available concerning the Yellow-legged frogs of California. In an extensive report Zweifel (1955, Univ. Calif. Pub. Zool., 54) reorganized the classification of the frogs and included data on distribution, physiology and ecology. Mullally and Cunningham (1956, Herpetologica, 12) presented further ecological and physiological information of *muscosa* in the Sierra Nevada.

This is one of the few species of frogs found at high elevations in the San Gabriel, San Bernardino and San Jacinto Mountains of Southern California. Less is known of it in these mountains than in the Sierra Nevada. The studies which are described herein were conducted in the San Bernardino Mountains at streams lying between 6,000 and 7,500 feet. These include Holcomb Creek, Van Dusen Creek, Dry Creek near Running Springs, Deep Creek in Snow Valley, Rathbone Creek in Moon Ridge Meadows and the Santa Ana River.

Habitat: Populations in the San Bernardino Mountains and the Sierra Nevada apparently differ in habitat preference: Zweifel (op. cit.) and Mullally and Cunningham (op. cit.) note that in the Sierra Nevada the frogs are as common or more common in glacial lakes than in streams. In the San Bernardino Mountains I have not found frogs in the glacially formed Dry and Dollar Lakes at elevations of 9,100 and 9,300 feet, respectively. These are the only lakes formed by glacial action in the mountains of California south of the Sierra Nevada. Neither have frogs been found in the artificial lakes, Arrowhead, Gregory, Little Green Valley, Big Bear and Jenks. The frogs apparently exist only in streams.

Frogs have not been found by me or others at elevations over 7,500 feet. I have not found any in South Fork Creek between 8,000 and 9,000 feet. It is known that in southern California *muscosa* occurs as low as 2,000 feet (Wright and Wright, 1949, Handbook of Frogs and Toads). However, in the Sierra Nevada the frogs rarely occur below 6,000 and range to 12,000 (Zweifel, op. cit.; Mullally and Cunningham, op. cit.). It would seem that either the frogs in southern California are physiologically adjusted to lower elevations or that the habitat at low elevations there is safer in some way than in the Sierra Nevada.

Frogs have been noted to inhabit streams varying in type from high gradiant with rocky courses to those low in gradiant with marshy margins and sod banks. At Snow Valley, stagnant pools with a scum of floating algae seemed to be avoided. Large, clear pools up to three feet deep were especially favored. Some form of shelter is required, and the frogs hide beside or beneath rocks, clumps of grass, banks, debris, etc. In the fall they often concentrate in shrunken streams in which only a trickle of water flows and where the pools are only a few inches deep and one or two feet across. Tolerance to low water levels is probably a factor that enables them to survive in the arid mountains of southern California.

Metamorphosis: In the Sierra Nevada, the tadpoles require more than one summer to metamorphose (Camp, 1917, Univ. Calif. Pub. Zool., 17; Grinnell and Storer, 1924, Animal Life in the Yosemite). Wright and

Wright (op. cit.) gathered data on the sizes of tadpoles on different dates in the San Bernardinos and concluded, "One wonders if they winter over as tadpoles." Doubt remained, and Zweifel did not mention this phenomenon in his extensive report. In recent years I have frequently witnessed overwintering of tadpoles in the San Bernardino Mountains. This characteristic, as well as others mentioned herein, probably indicate a close physiological similarity between the frogs of the Sierra Nevada and San Bernardino Mountains.

Tadpoles have been noted to overwinter in Van Dusen, Dry, and Deep Creeks. In the late spring the large tadpoles with rear legs which have overwintered, mix with very small ones from recently laid eggs. On May 28, 1955, at Snow Valley, a single laying of eggs was found on the bottom of a quiet pool six inches deep with a temperature of 19° (temperatures in Centigrade). The egg mass was globular and nearly 1.5 inches in diameter.

During the fall the pools are heavily populated with fairly uniform sized tadpoles because the large ones present in the spring have metamorphosed. However, for reasons of nutrition or disease an occasional one is extra large or small.

Habitat Desiccation: Inhabited creeks fluctuate and in some years dry up. In dry years water runs from spring to mid-summer, but in late summer or fall it disappears, killing the tadpoles. Frogs which are not killed by desiccation or predators apparently aestivate. They reappear with the return of water.

Deep Creek in Snow Valley has fluctuated over the years: In 1951, it had dried by the end of September, but in 1952, it ran all fall. On October 9, 1954, only scattered pools remained, holding many tadpoles. Later rains saved this population. The year 1955 was again pluvial, but by October 21, 1956, the streams had dried. No tadpoles or frogs were found in the soil of the moist depressions. In the fall of 1957, scattered pools developed as they had in 1954. In the fall of 1958 the stream ran strongly. The upper part of Van Dusen Creek fluctuated similarly. During most years, certain inhabited stretches of this creek dried.

Winter Temperature Relations: During the winters of 1954 and 1958 observations were made at Snow Valley on the habits of the overwintering tadpoles and frogs and environmental temperatures. On December 19, 1954, no activity was noted. Running water registered 1.9°, and three inches of snow covered the ground. Thin ice remained along the edges of the creek. On December 21, 1958, the stream was frozen over except where water moved fastest. Isolated pools were frozen six inches to their bottoms, and, perhaps because of the difficulty of searching, no specimens were found in them. In the flowing stream, pools held ice up to six inches thick. Where the creek was only several inches deep, the water temperature was nearly 1°, but in pools 18 inches deep it was 2.4°. No frogs of any age were active. After searching, an adult frog was flushed from a thick clump of submerged grass along the border of a large pool up to 15 inches deep. When disturbed in the 2° water, it swam slowly but in a coordinated fashion to the center of the pool. A recently metamorphosed frog was flushed from debris on the bottom of the same pool and it swam similarly.

After chopping a hole through five-inch ice on another pool 18 inches deep, I found a tadpole beneath a film of organic debris on the bottom, and another nearby similarly covered beside a small rock. They were difficult to find and well camouflaged. When disturbed they swam well and when pursued one increased its speed and swam quickly out of reach.

It thus seems that the tadpoles become dormant beneath rocks and debris in the streams but retain good swimming ability. Many adult and young remain in the streams all winter and retain good locomotor abilities. No frogs have been found dormant in terrestrial situations.

Body Temperatures during Voluntary Activity: During the season of activity the frogs live under a wide range of body and environmental temperature. On November 1, 1958, at Snow Valley, tadpoles and frogs of all ages were active in water of 5 to 7° after a frosty night. In the summer this stream usually registers between 9 and 14°. On August 16, 1954, frogs were present in Van Dusen Creek in waters of 13.8 to 14.5°. The body temperatures of three basking frogs were 20, 21.4 and 24.2°. The range of body temperature tolerated for activity thus has been noted to extend from, 5 to 24.2°. These values coincide fairly closely with those reported in the Sierra Nevada (Mullally and Cunningham, op. cit.)

Daily Period of Activity: Rana muscosa in the San Bernardino Mountains seem to be mainly diurnal, as the Sierra Nevada populations (Mullally and Cunningham, op. cit.). During daylight, all ages of frogs are active. After darkness begins most of the frogs cannot be located, but some have been seen resting quietly along the borders of the streams.

SAN FERNANDO HIGH SCHOOL, LOS ANGELES, CALIFORNIA

EARLY EMERGENCE OF *BUFO AMERICANUS* FROM HIBERNATION.—In New York reptiles and amphibians usually do not emerge from hibernation until the latter part of March. Occasionally a specimen may be found earlier, but it is unusual.

On February 13, 1959, an American Toad, *Bufo americanus,* was collected in Webster, New York, a suburb of Rochester. There had been about two inches of snow on the ground. On the 13th the temperature rose to the mid 40's F. Due to the slope of the ground, some of the run-off resulting from the melted snow flooded a window well on the south side of the writers house. A toad hibernating in the window well was aroused either by the water, the temperature, or both. The air temperature was 38° F. when the toad, a small, 34 mm. male was found floating in the water. It was extremely sluggish and able to make only a few, feeble, swimming motions, similar to treading water, primarily with its forefeet.—*Phil Skehan, Jr., 624 Lake Road, Webster, N.Y.*

A Population of the Six-Lined Racerunner (*Cnemidophorus sexlineatus*)

By CHARLES C. CARPENTER

The six-lined racerunner is a widely distributed and abundant species, ranging from the Atlantic coast to the Colorado Plateau and from the Great Lakes to the Gulf of Mexico. It is very abundant along the shore of Lake Texoma in south-central Oklahoma. A large population of these lizards existed on the northeast shore of Willis Island, three miles west of the University of Oklahoma Biological Station in Marshall County.

The study area (Racerunner Bluffs, Fig. 1) consisted of a sandy beach backed by sandy-clay terraces and a three to six foot bluff formed by the fluctuating levels of the lake which is a large flood control reservoir on the Red River. The area of the bluffs and beach chosen for study was 130 feet long and 40 to 50 feet wide, depending upon the lake level, and was gridded by using code-marked stakes at ten foot intervals. This population was completely destroyed by high floods in the spring of 1957.

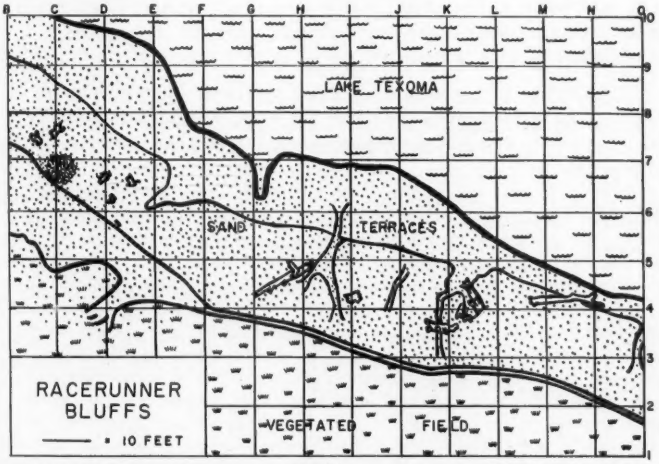

Fig. 1. Map or Racerunner Bluffs, east shore of Willis Island, Lake Texoma, three miles west of the University of Oklahoma Biological Station, Marshall County, Oklahoma.

Two methods of capture were used, the more difficult was by running the lizard down or cornering and grasping by hand; the other involved the use of modified "drift traps" (Fitch, 1951, Herpetologica 7;77-80). A trap was placed at either end of a 25 foot by 18 inch (¼ inch mesh) hardware cloth fence. A trap consisted of a gallon jar with a funnel of hardware cloth (one foot wide at the base, one inch opening at the apex) leading into and tied to the jar. A wire loop twisted to form four evenly spaced eyes was placed about the neck of the jar and small wire

loops were fastened to the sides of the funnel. The funnel could then be tied securely into the mouth of the jar, but could also be quickly loosened to enable the removal of captured lizards. These traps were also placed along the base of the bluff, the somewhat vertical sides of the bluff serving the same purpose as the fence in corraling the lizard and leading it into the funnel. Grass and weeds were placed over the traps for shade. The jar trap had an important advantage over one constructed only of hardware cloth because ants were excluded which could otherwise enter and attack and kill or weaken lizards. Frequently an elusive or very swift lizard was driven toward the fence or bluff and into a trap.

Captured lizards were toe-clipped and color marked for individual identification. The color marks remained for 24 hours to four or five days.

Most observations were made from the second week of June through the first week of August 1955 and 1956. Within this period, 67 separate trips were made to the area (39 in 1955 and 28 in 1956). The observational period for each trip varied from one to four hours. *Cnemidophorus* were also recorded on October 14, 1956, and May 26, 1957, (time of rising flood waters). Most observations were made between 8:00 a.m. and noon, a few in the afternoon and evening, and one series at night.

TABLE I

GROWTH RATE FOR *CNEMIDOPHORUS SEXLINEATUS*, DURING JUNE AND JULY 1955 AND 1956 IN SOUTH-CENTRAL OKLAHOMA

Range of Initial Body Length (cm.)	Females	♀ Growth cm. per mo.	♀ Growth % per mo.	Males	♂ Growth cm. per mo.	♂ Growth % per mo.
5.0-5.4	1	0.9780	19			9
5.5-5.9	1	0.7350	13	1	0.5010	9
6.0-6.4	1	0.3570	6	6	0.4839	8
6.5-6.9				11	0.4560	7
7.0-7.4	3	0.3030	4	8	0.0107	0.1
7.5-7.9	1	0.1200	2	2	0.0	0
8.0-8.4	2	0.0	0			
	9			28		

The rates of increase in body length are induced from measurements taken in June and July. The hatchlings showed the greatest proportional increase whereas the largest individuals had the least. The growth was analyzed in two ways; increase of body length in centimeters per month and per cent increase in body length per month (Table I).

Some indications of growth rate are indicated in the scatter diagram (Fig. 2). The young of the year form a very distinct group appearing first in July and showing growth through August and September. Some of this same group were detected the following May and June. By late June, the juvenile group appeared to merge with the adult population. Among the adults, ranging from body lengths of 6 cm. to greater than 8 cm., no distinct age groups were apparent.

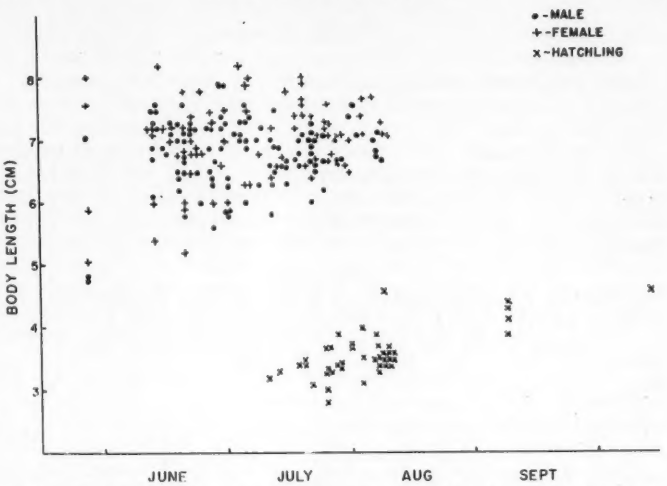

Fig. 2. Scatter diagram showing the relationship between body length (snout-vent) and date of capture in a population of *Cnemidophorus sexlineatus*.

The female growth rate (Table I) slightly exceeds that of the male. Support for this can be seen in the scatter diagram (Fig. 2) where the females formed a greater proportion of the individuals over 7.5 cm. and all the largest were females.

Although the data used here were primarily for June and July, they represent the periods of greatest activity and extend almost to the end of the known activity period for adults. By mid-August daily activity of adults was very short, few being observed and by early September it was difficult or impossible to locate an active adult. The hatchlings were active on warm days through September and early October and they also appeared earlier in the spring.

The difference in activity pattern between young and adults probably accounts for the greater annual growth observed for the young. The period of activity for the adults, during which most of the growth takes place, is primarily between early May and late August; that is, they had a growth period of only about four or five months.

During the two seasons 171 different individuals were captured; 49 males, 35 females and 11 hatchlings in 1955 and 21 males, 30 females and 31 hatchlings in 1956.

The males were observed more frequently in June and July when greatest activity occurred (Table II). Adult activity decreased in August when the hatchlings appeared and became the most active segment of the population.

During the summer of 1955, 43 were recorded on two or more days and 52 were identified only once. There were only 19 individuals seen on two or more days whereas 61 were identified only once during the summer of 1956.

TABLE II

FREQUENCY OF INDIVIDUALS OBSERVED IN A POPULATION OF *CNEMIDOPHORUS SEXLINEATUS* IN SOUTH-CENTRAL OKLAHOMA, 1955-56.

	May (little sampling)	June (12th on)	July	August (to 10th)
Male	3	42 (59%)	54 (50%)	7 (21%)
Female	4	29 (41%)	37 (33%)	7 (21%)
Hatchling	0	0	19 (17%)	19 (58%)

TABLE III

NUMBERS OF INDIVIDUAL RACERUNNERS OBSERVED ON THE STUDY AREA OVER EXTENDED PERIODS OF THE SAME YEAR IN SOUTH-CENTRAL OKLAHOMA, JUNE AND JULY

Intervals in days between first and last observations	1955	1956	Total
7 or more	36	15	51
14 or more	28	10	38
21 or more	22	5	27
28 or more	19	4	23
35 or more	13	2	15
42 or more	11	1	12
49 to 55	3	1	4

The two lizards seen over the maximum period of 55 days in one season were each recorded only twice. One each was observed as follows, 4 times in 50 days; three times in 49 days; 20 times in 47 days; 9 times in 47 days; 6 in 44 days; 4,4,5,5, and 7 times in 43 days; 14 and 11 times in 41 days; 13 times in 33 days; 6 and 5 in 32 days; 8 in 29 days; and 12 in 28 days. Those seen over a period of less than 4 weeks were recorded usually two or three times only.

Only six marked by clipping in 1955 were recaptured during 1956. The longest time between a first and last capture was 412 days (June 20, 1955 to August 6, 1956). This individual had been seen on four occasions over a period of fifty days in 1955, but was observed only once in 1956. One observed 20 different days in 1955 was seen three times in 1956, the first on June 22, 1955 and the last on July 10, 1956, a lapse of 383 days. The other extreme intervals between captures for the two years were 339, 339, 355 and 362 days.

The number of new individuals recorded for each trip ranged from 0 to 12, average 2.61 (1955—2.47; 1956—2.68). On many trips, no special effort was made to capture or identify all lizards seen, since most of the time was devoted to observing behavior.

The greatest number of different individuals observed in one week was 32 (July 21-27, 1955). That a total of 171 different racerunners was recorded suggests that a large population existed on the area. Calculation of population size using the Lincoln Index and a modified index of the same type (Hayne, 1949, Jour. Mammalogy 31:399-411) give results that seem to be out of line with observations (700 to 1282 in-

dividuals in 1955). The possible source of error is the paucity of returns the second year.

Behavior observations and observed and plotted movements indicate that certain individuals were much more frequently associated with the area than others. Attempts to trap in surrounding areas, particularly in the area of grass and forbs extending west from the top of the bluffs, did not yield any lizards. Since these traps were very effective on the study area, there is no reason to suppose that, were the lizards moving through this vegetation, they would not also go into the traps there. The east side of the area was formed by the lake, leaving the north and south routes along the terraced beach as the avenue for movement onto and away from the study area. Very few marked lizards were recorded as having moved away from the study area. There then should be indications that these lizards were remaining on the study area.

When the points of successive observations and captures of individuals observed three or more days were plotted and connected in sequence on a map of the study area, limited movement was indicated in two ways (Fig. 1 and 3 to be used together). Individuals were generally associated with a particular part of the area, that is, lizards observed at the south end rarely were recorded at the north end and vice versa. Individuals active in the central part of the area were usually seen in this area on successive observations. When the distance between the first and last capture of a lizard recorded on three or more days was compared to the distance between the two extreme (farthest apart) points of capture or observation, the latter was the greater distance in over 70 per cent of the 30 individual patterns available. These first-last-capture distances indicated a return towards the point of original capture and suggested limited movement. Some individuals were taken in the same traps three or four times in two or three weeks.

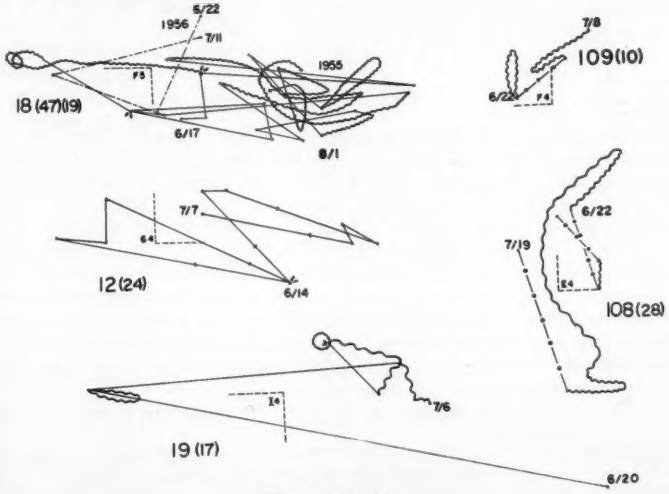

Fig. 3 (part)

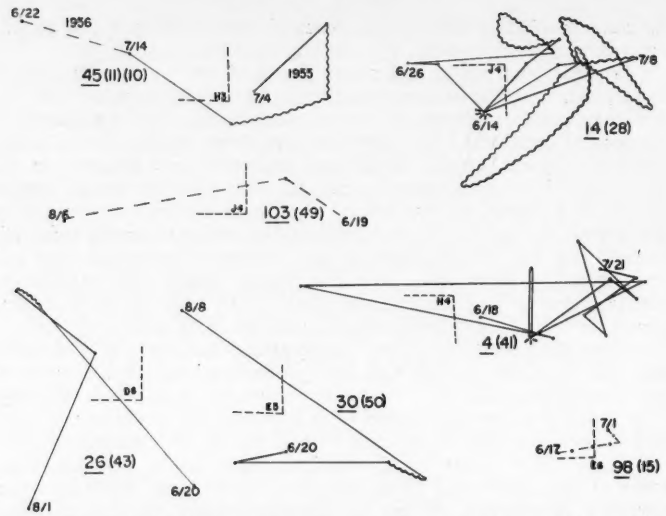

Fig. 3. Selected movement patterns indicating sequence of captures of individuals in a population of *Cnemidophorus sexlineatus*. Solid straight lines are between two sequential points of capture (1955). Broken lines in pattern are between sequential points of capture (1956). Solid wavy lines represent actual observed movements. Short radiating lines indicate the number of times this lizard was recorded at this point. Dates for first and last observations are indicated as month/day. The underlined number of the individual lizard is followed by the interval in days between first and last observations. The broken line right angles correspond to identically letter-numbered quadrants on the map (Figure 1). By superimposing the right angle over the proper quadrat corner, the relationship of the movement pattern to the study area can be noted.

The activities of particular individuals were followed from two to three hours when they were either within view of the observer or their location under a log, ledge or in a burrow was known. These individuals were frequently noted moving back and forth across a limited area. Certain individuals were regularly seen in a particular part of the area.

These data indicated that a segment of the population was somewhat stable. The fact that new individuals were continually appearing on the area would indicate there was extensive immigration and emigration. However, the trapping methods used to detect this failed. A large number or racerunners used the study area over the two year period and it is probable that during July and August the population at any one time varied between 50 and 100 individuals.

The cost of these figures was defrayed by a grant from the National Science Foundation.

DEPARTMENT OF ZOOLOGY, UNIVERSITY OF OKLAHOMA, NORMAN AND THE UNIVERSITY OF OKLAHOMA BIOLOGICAL STATION, WILLIS

Vertebra Duplication, an Osteological Anomaly Widespread in Snakes

By WAYNE KING

Herpetological literature contains numerous accounts of osteological anomalies in reptiles. Aside from the frequently reported kyphosis in turtles most of the anomalies involve a duplication of some part of the body. The most commonly reported are the conditions of polydactyly, bicephaly, or divided tails in snakes, lizards, turtles, and crocodilians. During the summer of 1958 I was making a series of skeletons of several snake genera for the University of Florida Collections. In the course of the work I noticed that several of the snakes possessed vertebrae which were duplicate on one side. Three ribs articulated with each of the anomalous vertebrae—two ribs on the duplicate side, one on the other. Examination of other specimens indicated this may be the most widespread skeletal anomaly to be found in snakes.

A typical example of this condition is the *Natrix natrix* vertebra shown in figure 1. It is duplicate on the left side. It has duplicate accessory processes; the anterior process arises just below the prezygapophysial facet, the posterior process arises from the interzygapophysial ridge. The prezygapophysical facet is not reproduced on the posterior accessory process. Both accessory processes project laterally. Below both of these processes are well developed paradiapophysial articular facets and parapophysial processes. The posterior edge of the neural arch, immediately above the zygantrum, is duplicated on the same side, but only the more posterior of the two edges bears an epizygapophysial spine and a postzygapophysial facet. The hypapophysis is double also; the posterior one is well developed and the anterior one is small and twisted to the left. The right side of the vertebra is normal; one rib articulates with that side, two ribs articulate with the left side. In one other duplicated vertebra which was examined, the hypapophysis is single.

The ribs are attached to the ventral scutes by cutaneous muscles. The extra rib of the duplicated vertebra, therefore, is indicated externally by a ventral scute that for half of its width is divided into two, or by a scute which extends only halfway across the venter. The appearance of these "half-ventrals" is shown in figure 1. If the anomalous vertebra had two complete ventral scutes it would approximate the condition found in the Typhlopidae, Leptotyphlopidae, and Uropeltidae—the possession of two ventral scutes per body segment (Camp, 1923, Bull. Amer. Mus. Nat. Hist. 48(11):289-481).

It is interesting to note that the two hypapophyses, found here as part of an anomaly, occur as the normal case only in the snakes of the extinct family Paleophiidae (Gilmore, 1938, Geol. Soc. Amer., Spec. Papers, 9:1-96). In the Paleophiidae the posterior hypapophysis is larger than the anterior one, as it is in the anomalous case above.

The "half-ventral" and corresponding vertebral duplication may occur anywhere along the body of the snake. As many as four "half-ventrals" were observed in one *Coluber*. The "half-ventral" has been

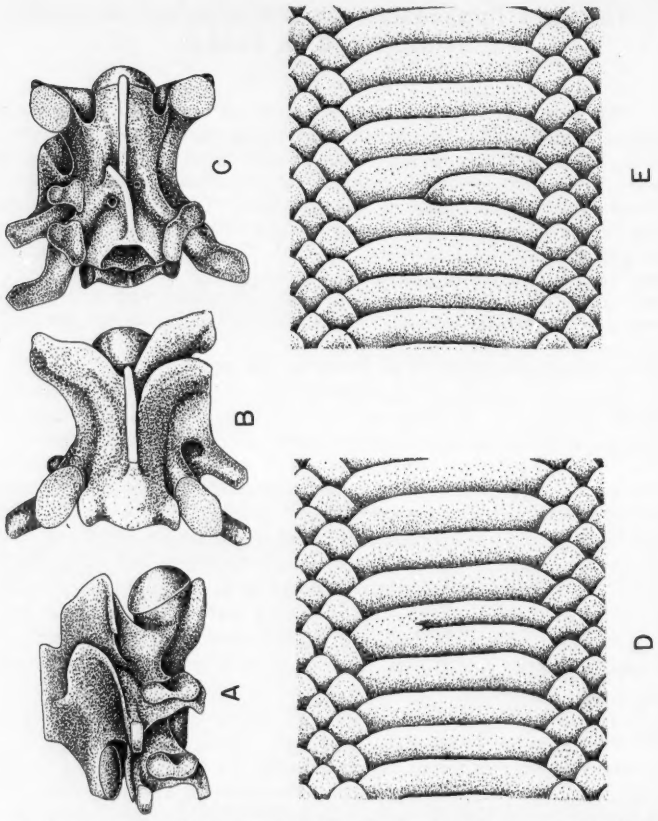

Fig. 1. Lateral (A), dorsal (B), and ventral (C) views of a duplicated vertebra from the European watersnake, *Natrix natrix*. Diagrammatic appearance of the "half-ventral" from *Diadophis punctatus* (D) and *Natrix natrix* (E).

found in snakes of the genus *Coluber, Diadophis, Elaphe, Lampropeltis, Natrix, Rhadinaea,* and *Thamnophis.*

DEPARTMENT OF BIOLOGY AND FLORIDA STATE MUSEUM, UNIVERSITY OF FLORIDA, GAINESVILLE.

A NEW SPECIES OF *SPHAERODACTYLUS* FROM ORIENTE, CUBA

By RODOLFO RUIBAL

In the past two years four new forms of *Sphaerodactylus* have been described from Cuba (Schwartz, 1958 and Grant, 1958, 1959a, 1959b). The species here described raises to eleven the number of forms ascribed to the island.

The new species is named in honor of Charles T. Ramsden who collected the type in 1914. The type is the specimen that Barbour and Ramsden (1919) identified as *S. nigropunctatus* Gray. Recently Grant (1957a) carefully analyzed the status of *nigropunctatus* and clearly demonstrated that the specimen described by Barbour did not fit the type of *nigropunctatus*.

Sphaerodactylus ramsdeni, sp. nov.

Type. Museum of Comparative Zoology 8536, collected at Monte Libano, Guantanamo, Oriente Province, Cuba, by Charles T. Ramsden in 1914. An adult female with a snout to vent length of 29 mm. and a tail 24 mm. long.

Diagnosis. The new species most closely resembles *S. goniorhynchus* of Jamaica. The two species differ from each other by the following: *S. ramsdeni* has small dorsals, smooth ventrals, smooth scales between the orbits, and a convex posterior margin to the caudals; in contrast *goniorhynchus* has larger dorsals, keeled ventrals, keeled scales between the orbits and pointed caudals. The new species also resembles *nicholsi*, of Puerto Rico, but the two can be easily distinguished by the larger dorsals and smaller size of *nicholsi*. *S. ramsdeni* differs from other known Cuban species by having a very large rostral bordered posteriorly by six scales (Fig. 1).

Description of type. Snout short (Table 1); rostral large, the posterodorsal portion depressed, with a partial suture and bordered posteriorly by six scales (two internasals plus four smaller scales; Fig. 1). Three supralabials on right side (two large scales and one small one below the eye) and four supralabials on left side (three large scales and one small one below the eye; Fig. 1). First infralabial very large, followed by two smaller infralabials. Mental bordered posteriorly by two postmentals. Scales of upper side of head, chin and throat smooth. No supraciliary spine present in the type. Scales of nape imbricate and smooth; dorsals triangular, keeled and imbricate to base of tail. Keels on dorsals evident at level of shoulder. No middorsal zone of reduced scales. Ventrals larger than dorsals and smooth. Some humeral scales with faint keels; forearm and hind limb scales smooth, but some scales of pes keeled. Caudal scales smooth with a convex posterior border; subcaudals smooth, the five proximal subcaudals transversely enlarged. Digital pads no wider than the subdigital lamellae (Fig. 2 L.).

Dorsal body color reddish brown; ventral body surface cream color. Three light colored nuchal spots; the central larger than the two lateral ones (see illustration in Barbour and Ramsden 1919, plate 3, figure 1). A light stripe runs from the posterodorsal corner of eye, along temporal

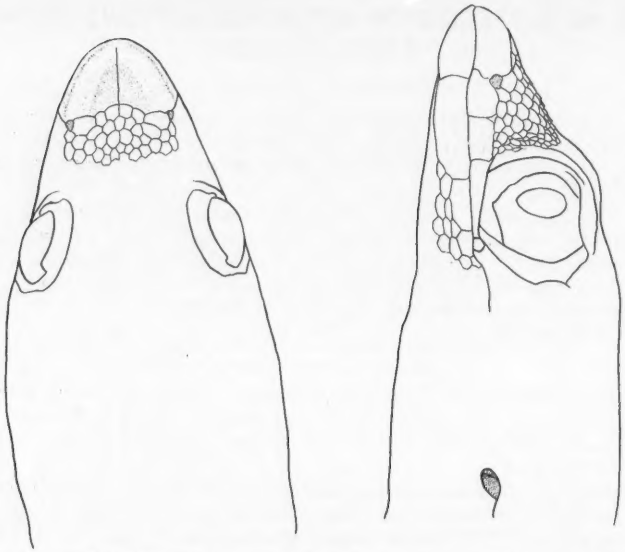

Fig. 1. (Left) Dorsal view of snout of the type *S. ramsdeni.* (Right) Lateral view of same.

area, to level of ear opening. A pair of paravertebral light stripes in the sacral region. Some small scattered dark dots over the dorsum.

Scale counts. There are 11 dorsals and 6 ventrals in the standard distance (the distance between middle of eye and tip of snout). The number of scales was measured by using a dissecting microscope with an ocular micrometer. This method of measuring is more accurate and reliable than the more standard method of using calipers.

Remarks. No information regarding the escutcheon is available since the solitary type is a female. The snout of *ramsdeni* is shorter than in any other Cuban species. This is shown in Table 1, where the ratios obtained by dividing the distance from the ear opening to center of eye by the standard distance have been tabulated. These measurements were made as mentioned above. As stated in the diagnosis *ramsdeni, nicholsi,* and *goniorhynchus* appear to be closely related species. All three resemble each other in: 1. Short snout. 2. Large rostral with a posterior depression and partial suture. 3. Six scales bordering rostral posteriorly. 4. Shape and size of labials. 5. Small digital pad. This complex of characters readily distinguishes these three species from all other known species.

Discussion. Grant (1957a, 1957b) has indicated that there has been unwarranted doubt regarding the presence of *argus* in Cuba and confusion regarding specimens of *argus* labelled *nigropunctatus.* It would thus be useful to indicate here that *ramsdeni* is easily distinguished from *argus* by the following:

S. ramsdeni

1. Short snout (Table 1)
2. Rostral with 6 scales along posterior border.
3. 3 to 4 supralabials unequal in size.
4. Digital pad small (Fig. 2 L.).

S. argus

1. Longer snout.
2. Rostral with 3 scales along posterior border.
3. 4 equal supralabials.
4. Digital pad larger (Fig. 2 R.).

Fig. 2. (Left) Ventral view of digital pad on fourth toe, right pes, of the type of *S. ramdeni.* (Right) Ventral view of digital pad on fourth toe, right pes, of *S. argus* from Camaguey, Cuba.

Grant recorded *argus* from Cienfuegos, on the south coast of Las Villas. I have collected this species on the keys off the south coast of Camaguey and at Santa Cruz del Sur, Camaguey (specimens in the M.C.Z.). The American Museum of Natural History has specimens collected near Manzanillo, Oriente. The species thus has an extensive distribution along the south coast of Cuba. On the keys off the coast of Camaguey *argus* is abundant in the dead trunks of large mangroves where it is found with *Tarentola americana* (Ruibal, 1958). Its wide distribution from Las Villas to Oriente and its association with *Tarentola* on the keys is indicative of a long residence in Cuba, and thus would contradict the suggestion that has been made by Schwartz (op. cit.) and Barbour (1937) that *argus* has been recently introduced. Further, the morphology of *argus* from Camaguey differs from the spotted eastern Jamaican subspecies in regard to the degree of spotting and size of spots and may thus represent a distinct subspecies.

Barbour and Loveridge (Grant, 1944) questioned the validity of *oliveri* and considered it identical to *scaber*. *S. scaber* was described by Barbour and Ramsden (op. cit.) from Camaguey, Sierra de los Perros, near the Camaguey-Las Villas boundary, and it has also been recorded from the Sierra de Jatibonico in Las Villas (M.C.Z. 7952). I have collected it in the Sierra de Najasa in extreme eastern Camaguey (specimens in the M.C.Z.) In 1944 Grant described *oliveri* from near Cienfuegos in Las Villas. This species has also been recorded from the Sierra de Trinidad. As Grant indicated, these two species are easily distinguished by their color pattern and scalation. I have measured the scales and find that *oliveri* has 10-12 dorsal scales to the standard distance (7 specimens measured including the type and paratype) whereas *scaber* has 5-8 (8 specimens measured including the type). The Sierra de Jatibonico and the Sierra de Trinidad are close enough for one to speculate about what species is to be found in the area between the two.

Although it would seem appropriate at this time to provide a review and key to the Cuban species of *Sphaerodactylus,* I have found that, for the moment, this is an impossible task. The distribution and ecology of the three new species (*alayoi, spielmani,* and *ruibali*) described by Grant from Guantanamo, Oriente have yet to be determined. The relation of these new species to *torrei* is also unclear. Similarly Schwartz's new form, *S. decoratus drapetiscus,* raises the question of the distribution of *drapetiscus* and its relation to *torrei.* Grant (1959a) has suggested that decoratus be considered as a distinct species restricted to the Bahamas and that *drapetiscus* and *torrei* be considered as separate Cuban species. At present I believe that *decoratus, drapetiscus* and *torrei* do represent subspecies, but this is only an opinion and it will be necessary to analyze the Bahaman forms and determine the distribution and variation of *torrei* and *drapetiscus* before this question can be settled.

In the list below, the various forms have been grouped according to morphology and the known distribution of each species is provided. The list contains four species which are known only from the vicinity of Guantanamo. This is evidence of the need for more field work before the interrelationships of the various species can be determined with certainty.

List of Cuban species of *Sphaerodactylus*

1. Species having 15 to 26 granular dorsal scales in the standard distance.

S. cinereus	Pinar del Rio to western Oriente
S. torrei	Oriente and (?) Camaguey
S. drapetiscus	North coast of Habana and Matanzas
S. spielmani	Guantanamo, Oriente
S. alayoi	Guantanamo, Oriente
S. ruibali	Guantanamo, Oriente

2. Species having 4 to 14 keeled and imbricated dorsal scales in the standard distance.

S. notatus	Islandwide
S. argus	Southcoast from Las Villas to Manzanillo, Oriente.
S. ramsdeni	Guantanamo, Oriente

3. Species with large dorsals and a narrow middorsal zone of reduced scales.

S. scaber	Las Villas and Camaguey
S. oliveri	Las Villas

Acknowledgments. The opportunity of examining the *Sphaerodactylus* at the M.C.Z. and of collecting this genus in Camaguey was provided by a grant from the American Philosophical Society in 1957. I here take the opportunity of thanking the Society for its assistance. The illustrations of the head of *ramsdeni* were made by Miss Dereth Bogert.

Table 1

Comparison of the snout length of eight Cuban species of *Sphaerodactylus*. A ratio expressing the snout length is obtained by dividing the distance from the ear to the center of the eye by the standard distance. The higher the value of the ratio the shorter the snout.

SPECIES	SPECIMENS	Ear-Center of Eye ÷ Standard Distance MEAN VALUE	RANGE
S. ramsdeni	1	1.00	
S. argus	20	.83	.80 - .92
S. cinereus	30	.82	.71 - .89
S. notatus	15	.90	.85 - .95
S. torrei	13	.83	.77 - .92
S. drapetiscus	5	.82	.79 - .88
S. scaber	8	.78	.75 - .82
S. oliveri	6	.81	.76 - .85

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DIVISION OF LIFE SCIENCES, UNIVERSITY OF CALIFORNIA, RIVERSIDE, CALIFORNIA

A SOUTHERN RINGNECK SNAKE OF RECORD SIZE.—Conant in his 1958 *Field Guide* records 17½ in. (445 mm.) as the maximum size recorded for *Diadophis p. punctatus*. The North Carolina State Museum of Natural History contains one example exceeding this length. NCSM 51-10-3, originally taken near Raleigh, Wake Co., Oct. 3, 1951, by Mrs. W. T. Norris. The snake is a female measuring 457 mm. (18 in.) total length in the preserved state, and 470 mm. (18.5 in.) immediately after death as recorded in the accession catalog.—*W. M. Palmer, North Carolina State Museum of Natural History, Raleigh, North Carolina.*

FIVE NEW RECORDS OF *PITUOPHIS* IN KENTUCKY.—Only two heretofore published records of *Pituophis* from Kentucky are substantiated by extant specimens: Hibbard (1937, Trans. Kans. Acad. Sci., 39: 277-281) reported a specimen taken in Edmonson Co. and deposited in the collection of the Mammoth Cave National Park Museum; and Savage (1948, Copeia, :302) recorded one from Trigg Co., presented to the N. H. M. of Stanford University. Because of this paucity of study material, records of the specimens I have assembled are herein noted.

Two specimens of *Pituophis* were collected near Fenton, Trigg Co., July 25, 1957, and July 26, 1958, by Tom Boone, and another Aug. 8, 1958, by Robert Miller. The first was placed in the collection of the Dept. of Biol., University of Louisville (UL 9453); the others are alive in my collection.

A fourth Pituophis was found 10 mi. E. Murray, Calloway Co., May 12, 1958, by Herbert Robertson, and is alive in my collection. This is not only a new county record, but also establishes the species west of Kentucky Lake (Tennessee River) and in the physiographic region of Kentucky known as the Jackson Purchase.

A fifth was taken near Hardyville, Hart Co., May 15, 1958, and was given to me by John Sullivan, proprietor of the Free Zoo, Cave City, Kentucky. The specimen is preserved and in my collection.

Heretofore, this genus was thought to be very rare in Kentucky. The fact that five of these snakes have come to hand within a period of less than 13 months indicates that it is not uncommon to some sections of the state.

Although all previously recorded specimens from Kentucky have been assigned to *P. m. melanoleucus*, certain features of scutellation and maculation of the specimens reported herein cause me to be reluctant to make a subspecific determination. A study of the systematics and ecology of the snake is being continued by the author.—*Tom C. Fuller, Kentucky Department of Fish and Wildlife Resources, 1247 S. Floyd St., Louisville 3, Kentucky.*

FURTHER RECORDS OF THE SMOOTH GREEN SNAKE IN THE VIRGINIA BLUE RIDGE MOUNTAINS.—The Smooth Green Snake, *Opheodrys vernalis vernalis* (Harlan) had previously been reported in Virginia only from the Clifton Forge area (Hoffman, 1945, Herpetologica, 2:203) when Witt (1958, Herpetologica, 3:140) reported specimens from two other localities in Amherst and Page counties.

Two preserved specimens in my private collection provide additional locality records. Both were collected June 28, 1957, along the Blue Ridge Parkway, one (1101) near Clarks Gap (elev. 2177 feet), Rockbridge Co., the other (1103) contained two fully formed eggs, from near Iron Mine Hollow, Botetourt Co.

I wish to thank Mr. Ralph F. Daffin for his aid in the identification of these specimens.—*Donald W. Linzey, 4216 Hamilton Avenue, Baltimore 6, Maryland.*

ADDITIONAL PRINCIPLES OF PATTERN EVOLUTION IN HERPTILES.—In 1953 an important paper on some of the basic principles of pattern evolution in snakes, by Marianne von Harnack, was published (Die Hautzeichnungen der Schlangen, Zeitsch. Morph. Ökol. Tiere, Vol. 41, pp. 513-573, figs. 1-129). Klauber subsequently (1956, Rattlesnakes, Univ. Calif. Press, vol. 1, pp. 205-207) remarked upon pattern evolution in rattlesnakes (*Crotalus*) and certain bullsnakes (*Pituophis*) and kingsnakes (*Lampropeltis*), stating that "In snakes usually having blotches or rings, some aberration in the genic mechanism may cause a peculiar 90-degree rotation of the pattern, whereby transverse blotches or rings are transformed into longitudinal stripes." The close relationship of ringed and striped patterns has long been known to herpetologists, and has been discussed in detail by Harnack. It is certainly a 90-degree rotation of *orientation* of major elements that is involved, but certainly no *actual* rotation of spots or stripes can have occurred in evolution, despite the possibility of such an inference from the preceding quotation from Klauber. On the same page (4th par.) Klauber makes clear that he envisions the pattern transformation as a product partly of fusion of blotches, partly of addition of new material.

Curiously, neither Klauber nor Harnack explored the significance of bi-laterality in pattern evolution. We regard it a factor of major importance.

Tracing pattern evolution from its earliest beginnings, it is evident that the basis for color patterns is melanin. Particles of melanin seem to be mutually attractive and readily evolve from a state of even distribution to concentrations. The basic evolutionary process is ontogenetically evident in many turtles, for example the *Pseudemys* of Jamaica, wherein the melanin migrates to the dorsal sutures in maturation of males. In black-banded *Sphaerodactylus* the melanin becomes heavier along the edges of the bands, thus splitting each into two rings; the melanin does not enter the white bands. In lizards such as *Aristelliger,* a ringed tail when reproduced usually bears a striped, perhaps ancestral pattern.

From facts such as these, and from many years of study of the subject, one of us (Grant) formulated an hypothesis of three-stage evolution of pattern in snakes. First, the primordial coloration of lizards and their derivates was a product of a fairly even distribution of melanin, causing a gray body. The melanin subsequently broke up by migration of particles into a pattern of rows of spots, and from this *spotted* pattern, all other patterns evolved, with rings, stripes and larger spots (*blotches*) forming by different combinations of coalescence and expansion. The end result in certain lines of evolution was a return to the original unicolor pattern. This is precisely the hypothesis independently advanced by Harnack. She suggests that the spots were primitively arranged in 6 rows, 3 to a side. As hypothesized by Riemer (1958, Nat. Hist. Misc., Chi. Acad. Sci., 165: 8-9), the genic bases for blotched as opposed to striped patterns may be quite "separate and non-conflicting," and the shift from one pattern to the other "may be due to some relatively simple genic mechanism."

To these basic concepts we can add five general principles. First, aggregation of the melanin to form the primitive spotted pattern seemingly occurred without aid of natural selection (see preceding paragraphs),

whereas further modification was influenced importantly by natural selection. That pattern is important in survival has been demonstrated by Klauber (1931, Bull. Zool. Soc. San Diego, 8:45-46.) and is corroborated by Grant's observations. A blotched pattern is more protective in a quiescent or slow-moving species whereas a striped pattern is adaptive for rapidly moving species. The senior author has frequently observed a striped snake escaping through grass where an intermittent view is offered. The illusion is of a stationary section of the snake. Under the same conditions a snake with a broken pattern reveals its motion even if only one small section is visible at a time through leaves or grass.

Secondly, it is evident that the location of the primitive spots was segmental, correlated with ventral or dorsal scutes or scales, in turn with ribs and vertebrae. Vertical coalescence of spots led to formation of rings, horizontal coalescence to stripes, and varied combinations of limited horizontal and vertical coalescence to varied patterns of blotches.

Thirdly, the patterns of the two sides of the body seem to be inherited or controlled independently. Disruption of ringed or blotched patterns is limited to the middorsal and midventral seams.* Evidence has been presented elsewhere of the primitive occurrence in scutellation of the body of median seams and numerous rows of ventrals in snakes (Grant, Amer. Midl. Nat., 16:921-931, 1935; and Proc. Indiana Acad. Sci. 46:240-252, 1937).

If the second and third proposals are in general true then there should be a bilateral independence in somatic structures comparable to that in pattern. Evidence thereof is displayed in a caecilian amphibian, *Dermophis m. mexicanus,* seven of which (UIMNH 45943-7) were taken by Grant in December, 1958, on the slopes of Volcan Santa Clara, Suchitepequez, Guatemala, 5000′. A few primary and secondary rings are offset at middorsum, and many are offset at midventral line.

Fourthly, it is our observation that dislocation of pattern occurs more frequently in the "lumbar" region than elsewhere. Corroboration is furnished by the caecilians cited previously, in which the rings are offset more frequently toward rear of the trunk.

Fifthly, we regard the area of greatest pattern instability, therefore the center of pattern change, as the rear lumbar region a short distance in front of the vent. The preceding fourth principle bears out the fifth, and so also does Harnack's conclusion that in some cases the cephalic pattern is primitive, in others the caudal pattern is primitive. It is our proposal that in general the changes are initiated just posterior to midbody, and that sometimes the cranial pattern is the last to be affected by the change whereas in other cases the tail is the "most resistant" to change.

Harnack has concluded that the dorsal zones, as opposed to the lateral and ventral zone, always show the highest degree of symmetry and the strongest contrast. We induce the same, and cite as an interesting somatic correlation the fact that the rings in the previously-cited caecilians are much more frequently offset ventrally than dorsally—*Chapman Grant, Route 1, Box 80, Escondido, California, and Hobart M. Smith, Dept. Zoology, Univ. Illinois, Urbana.*

*Smith believes there is a possibility that somatic structures with correlated pattern, might be staggered at levels lateral to middorsal or midventral lines.

Herpetology of Barbados, B.W.I.*

By CHAPMAN GRANT

Barbados lies about 100 miles east of St. Vincent and the same distance from the Antillean arc of stepping-stone islands which probably constituted an ancient trade route. Its isolated position and the fact that the trade winds blow from Spain and Africa probably account for its depauperate vertebrate population. It is bluntly triangular, about 20 miles long n-s by 14 wide with no offshore islets.

History is uncertain as to who discovered the island or how it acquired its name. It comes into clear focus as a British possession with a large African slave population and noted as a source of rum. It is gently rolling save for the steeper east side and is devoted to growing sugar cane by the same methods used in slavery days save for the aid of a few dilapidated trucks. There is very little livestock. Apparently the theory in vogue is that the more primitive the method of labor, the more employment is available. A result is that citrus and other fruit is imported as well as meat. Only a few distilleries remain in operation. There are few tourist attractions.

Barbados herpetology could be dismissed with the remark that in precolumbian times the only reptiles were *Dromicus perfuscus* and possibly *Kentropyx intermedius,* but since I made a trip there in Jan. 1957, it may be worth while to go into some detail.

BARBADOS HERPTILES IN MUSEUMS AND COLLECTIONS

	Chicago M.N.H.	British M.N.H.	Am. Mus. N.H.	U.S.N.M.	M.C.Z.	Phila. Acad.	M.Z., U. Mich.	C. Grant	W. G. Lynn	Totals
Bufo	3			14			3	2		22
Eleutherodactylus	11			5	4		2	20		42
Hemidactylus	1		1	2				6	1	11
Anolis	4	12	14	24	17		1	12	6	90
Gymnophthalmus	4			2	15			1		22
Kentropyx		5		5	4	2			1	17
Dromicus		4		2						6
Phyllodactylus?		1		3						4
Mabuya		1		2						3
Leptotyphlops										0

*The proper name of the island is "Barbados," but it is frequently called "The Barbados."

The first mention of herptiles that I have seen is in the Natural History of the Barbados, Mr. Griffith Hughes, A. M., London, 1700. He mentions the spotted lizard or Poisonous Lizard (*Hemidactylus*), proving that it had already been introduced accidentally with the slaves. He also lists the Green Lizard, (*Anolis*) which was probably endemic.

Sir Robert H. Schomburgk wrote The (Civil) History of the Barbados, 1848, devoting one page to a list of herptiles which he apparently believed might inhabit the island. His familiarity with Sloane and Browne is evident from the species he listed which occur on other islands.

Since then only brief notes have appeared or species believed to exist on the island have been included in papers on their respective genera. These fragmentary references are not here recorded.

Of the 7 species definitely present today, two appear to be endemic and 5 introduced. Others have been catalogued on little or no evidence.

The principal museums in the U.S. as well as the British Museum sent lists of their Barbados specimens.

Bufo marinus Linnaeus

Schomburgk.—"Bufo agua, Daud.; Spix. The Toad, or Crapeau. I have been assured that this species, which is so common on Demarara, was introduced from thence about fifteen years ago.—[1883]— It has increased most rapidly, and is now to be met with in as large numbers as in Demarara . . ."

At present of such spotty occurrence as to appear scarce in comparison to its numbers on other West Indian islands.

Eleutherodactylus martinicensis (Tschudi)

Barbour, (Mem. MCZ, vol 44, 1914, p. 241) states that *martinicensis* is really *auriculatus* of Puerto Rico (now *portoricensis* Schmidt) and that it was introduced into Jamaica. Neither statement is substantiated or correct. He states that Fielden (Zoologist, 1889, p. 298) gives no clue as to the origin of its introduction into Barbados. Reinhardt and Lutken (Vid. Middel. nat. foren. Kjobenh., 1863, p. 159) record it from Barbados. Barbour (op. cit. p. 249) describes *johnstonei,* Types 2759 MCZ, from Grenada quoting; "Mr. Septimus Ward tells me that this small piping frog was introduced about 25 years ago (i.e. about 1885) from Barbados." Barbour regrets describing this species from Grenada specimens which he believed had been introduced from Barbados.

Barbour, (Zoologica, NYZS, 1930, p. 77) states that *johnstonei* "has recently appeared in Bermuda," but he makes no mention of its existence in Barbados. On p. 76 he lists *martinicensis* without mention of Barbados. The species *johnstonei* has been dropped from the literature.

Numerous under trash in moist spots.

Hemidactylus mabouia (Moreau de Jonnes)

First mentioned by Hughes, 1700, p. 64, who says that the Spotted Lizard or Poisonous Lizard exudes viscous matter from the spongy indentures of its toes enabling it to walk on smooth vertical surfaces.

The natives now refer to this locally uncommon gecko as the White or Poison Lizard and are in great fear of it. Schomburk, p. 145; ". . . even in 1650, the number of negroes was estimated at 30,000. In 1817 there were 77,273." An ethnologist might be able to determine from what parts of Africa the British obtained their slaves by deter-

mining the African ranges of the several species of geckos inhabiting the Caribbean islets or parts of larger islands since this lizard is claimed to have been accidentally imported with the slaves.*

I have studied large series of this species from other of the W. I. Islands, (Jour. Dept. Agr., P.R., v. 16, Jan., 1932 pp. 55-6) and note that the Barbados population differs slightly in having 13-13 femoral pores instead of 16 to 17 and that the center pair of chin shields does not reach the 2nd labial instead of touching part of it.

Its habits resemble other W. I. populations, hiding by day and seen at night near artificial lights.

Anolis roquet extremus Garman

Hughes mentions the Green Lizard in 1700, consequently if it is an introduction, it was precolumbian or introduced by early explorers. I doubt the latter since there is no record of this genus having been introduced from one island to another except purposely in recent times. It is as likely to be endemic as is any of the genus elsewhere.

We place the form in *extremus* since Barbados is the type locality. (Garman, Bull. Essex Inst., vol. 19:11, 1887).

Now common; usually seen on tree trunks; fan small, greenish yellow; on the west coast the eyeball is blue; specimens from the east coast lacked blue eyeballs. A large male, hanging head down, on the bole of a cocoanut palm had head and distil half of tail mauve; remainder green; black around eye; eyeball conspicuously blue; shoulders and part of back checkerboard black and light gray.

After dark it takes over the role played by *Hemidactylus* on other Caribbean islands by clinging to walls near artificial lights in order to catch and eat insects. I saw a large one catch and eat a large moth at night near an electric light. I have never seen nocturnal activity in this genus elsewhere. At night about the same proportion retain the green color as in the day, which is about one half; the remainder are brown, but I have watched specimens change from brown to green and vice-versa.

Gymnophthalmus underwoodi Grant

For original description see Herpetologica, 14, 4:227-8, Dec. 1, 1958.

This species is not rare, but difficult to find except under well decomposed trash piles.

Kentropyx copei Garman

Barbour had the following to say, (1914:308). "Cope first recorded this species (*Centropyx intermedius*) from Barbados; and I cannot find the slightest difference between specimens from Barbados and the description of mainland specimens . . . Garman's name, *C. copii* MCZ No. 6076 is a nomen nudum." 1937:140 he changes the spelling: "*Kentropyx intermedius* Gray. Northern S.A., Barbados. This species . . .

*My reason for questioning an accidental introduction of this genus is the possibility of its having been purposely, but clandestinally introduced by sorcerers to terrify their victims. It might be stated in rebuttal that no such explanation could be ascribed for the presence of "Asian" geckos on the west coast of Mexico. I believe that the west coast geckos are endemic.

formerly abundant . . . now wholly extinct on Barbados . . . identical with Guiana . . . may have been artificially introduced."

The British Museum still adheres to the earlier spelling of which Dr. Hobart M. Smith says: "Resolution of the question of the proper orthography for *Kentropyx* Spix, hinges upon a more general question: can an "Original Spelling" be regarded as "Valid" (the one and only acceptable spelling) if it involves an error of transliteration, or is it to be regarded as "Invalid?" (This is the terminology of the Copenhagen Decisions on Zoological Nomenclature, 1953). Only if the *spelling* is "Invalid" can it be corrected by emendation, although if emended the emended name retains the date and authorship of the Invalid Original spelling it replaces.

"Klauber (Copeia, 1956, No. 4) has already pointed out that the Copenhagen Decisions unequivocally establish that an error of transliteration does not constitute an "inadvertent error"—the only sort that can be emended. *Kentropyx* cannot be replaced by *Centropyx.*"

"This is *Kentropyx copei* Garman if it is different from the South American *intermedius. I* go along with Garman. Barbour is not correct in saying that Garman's *copii* is a *nomen nudum,* because Garman referred to Cope, 1861, Proc. Acad. Nat. Sci. Phila., :496. The name *copii* is, on that basis perfectly aceptable in nomenclature. Garman's statement clearly states that Cope's description is now the description of his, Garman's, *copii,* in spite of the fact that Cope used a different name (*intermedius*) for it.

"In line with recent dicta it is permissible to change endings to their proper forms. This should be *copei,* not *copii.* Using *Kentropyx* instead of *Centropyx* as of Garman does not require parentheses around Garman's name."

This lizard is still found among the dunes of the east shore where I saw the tracks of feet and tails, but the sun being obscured, the animals had holed up as *Ameiva* does. Mr. Garth Underwood in letter dated July 2, 1957 states: "I have seen the 'extinct' *Kentropyx* in Bridgetown, up the rivulet."

Dromicus perfuscus (Cope)

Schomburk, p. 679. "Only one kind of snake is found in Barbados and there appear to be so few that the sight of one is considered a rare occurrence. From the description which has been given me it is probably a species of *Tortrix.* It possesses no poisonous fangs and is perfectly harmless." He also lists the mammals, :682-3 without mention of the mongoose which was introduced into Trinidad in 1870 and Jamaica in 1872 and probably into Barbados at about that period. The snake must have become rare for causes other than the mongoose or man. I found no one who had seen a living specimen.

Phyllodactylus pulcher Gray

Dr. Cochran says: "*Phyllodactylus spatulatus* USNM 6040 was described from three individuals from Barbados collected by Dr. Theo. Gill. There are still 3 specimens in the jar here, but as Cope visited London in the early 1860s he may have identified one in their collection as that species although he names no Brit. Mus. material in his original description."

Dr. H. M. Smith says: "Both *pulcher* and *spatulatus* are seemingly

based upon Barbados specimens and seemingly are identical and furthermore are apparently endemic—anyhow they are not known from elsewhere. Since at least 2 collectors (BMNH and USNM) are reported to have taken specimens, I would not reject this species as occurring in Barbados."

I did not see or hear of the genus.

Mabuya mabouya mabouya (Lacepede)

Dr. Cochran writes Mar. 12, 1957. "Prof. Gill's collection is all labeled 'Barbados,' but some entries have been questioned, such as *'Elaps fulvius.'* . . . on which 'U.S.' has been written, so you have the right to doubt Barbados as locality of No. 6041 *Mabuya lanceolata.*"

This seems to be sufficient evidence to drop the species from Barbados and I doubt whether this species was taken on Barbados. However, in my collection of over 7,000 specimens from Puerto Rico, (1930-32), I took only one *Mabouya* although they were plentiful on surrounding islets. I therefore refrain from saying "extinct."

Leptotyphlops bilineata (Boulenger)

Glauconia bilineata Boulenger, Cat. Sn. Brit. Mus. vol. 1, 1893:70. Lists 2 specimens from Barbados, coll. Col. Fielden; half grown. These two specimens are supposed to be in the Brit. Mus., but Mr. Parker did not list any specimens as present.

Inasmuch as this family is represented on the Hawaiian Islands and Grand Cayman it may also occur here, but there is no physical evidence of it at this time.

ROUTE 1, BOX 80, ESCONDIDO, CALIF.

NOTES ON BEHAVIOR OF *GOPHERUS POLYPHEMUS.* — A study was begun in Forrest County, Mississippi during the summer of 1951 on the gopher tortoise. The first excavations of dens were made by the writer and student help during a heavy rain, for the purpose of learning what animals would take refuge in them.

At the first den three quail were encountered that flew out past our shovels. Nothing else was seen until the bottom was reached, where we found two *Rana pipiens,* one *Bufo terrestris,* three half grown field rats, two common crickets, *Acheta assimilis,* eleven cave crickets, *Ceuthophilus gracillipes* and hundreds of large gnats, but the tortoise was not in the den. We set up a watch to see whether it would return during the rain and proceeded to excavate a second den, which proved to be 18 feet long with a maximum depth of over 7 feet. Before any digging was done, a box tortoise that was sitting about two feet within the entrance was removed. In the next 5 feet, five cave crickets and a small gopher tortoise, 60 mm. wide were taken, but no large gopher tortoise was found.

After five and a half hours of waiting the rain ceased. About two and a half hours previously, the first tortoise returned to its den. The second returned in seven and a half hours.

On June 4 it started raining in early morning. Traps were dug in front of 15 dens and trip mechanisms were set up in the dens and about the traps to indicate whether the turtles caught were leaving or returning. This was to find out whether the tortoises were in their dens without having to dig them up. The dens were numbered and the traps were run

every two hours. During the course of the study eleven of the fifteen tortoises were caught, nine were returning to their dens. The first homing tortoise was taken at the end of the fourth hour. At the end of the seventh hour the rain had stopped. The second was taken at the end of the eighth hour and the third by the twelfth hour, when it had started raining again. The rain continued for three and a half hours. No more tortoises were taken until the twenty-seventh hour when six more returned to their dens.

Trip devices were set up in an additional 15 holes on June 4 at 5:15 P.M. It began to rain at 6:20 P.M. and continued until 7:15 P.M. The first tortoise returned at 9:30 P.M. By dawn of the next day 11 had returned. When they had returned to their dens, attempts were made to determine what factors might affect their return to the field. Seventy-five percent merged from their dens about 10:20 A.M. They did not return until June 6 when 13 of the 15 had returned by 1:20 P.M. and the others by June 7 at 10:20 A.M.

The field life of the gopher tortoise is not disturbed by rain. They sometimes leave their dens by day and are gone over night or sometimes they may leave by night.

During excavation of the dens, pieces of mushroom were found which showed signs of having been chewed. Later a gopher tortoise was caught a few feet from its den with a portion of a mushroom in its mouth. When gopher tortoises are kept in captivity they eat vegetable matter and such things as salmon and hamburger meat.

The gopher tortoise at times is a clean housekeeper. The writer has observed them in late summer backing out of their holes dragging and scraping dung and trash several feet beyond the entrances. In winter and early spring one will find large amounts of dung at the bottom of the den. In many cases the tortoise will go a few feet outside of its den to defecate and then return.

It will swim of its own accord in both fresh and brackish water. A gopher tortoise at the Gulf Coast Research Laboratory swims the boat slip, a dredged channel about sixty feet wide, in order to get to a wooded area nearby. He is a very slow swimmer, maintaining a fairly regular course, but does not follow the same path in and out of the boat slip.

Some consistency in following definite paths when leaving and returning to the den can be seen. Destruction of these paths does not hinder it from finding its den. On one occasion the writer planted gallberry (*Ilex glabra*) bushes down the middle and across the paths approaching a den, but the tortoise simply bulldozed through and took up a new route.

On three occasions the writer found marked tortoises returning to dens which they had abandoned for five months.

During the course of the study, forty egg burrows of *Gopherus polyphemus* were observed. Most of the five or six eggs laid in each hatched, but only about half of the young dug out. The others died in the nest. The writer attributes this to the hard packed overburden. The hachlings are not strong enough to dig out. In south Mississippi the dens and egg burrows are often dug in gravel and clay hills which pack firmly and the soft claws on the burrowing feet are useless in many cases.—*William E. Brode, Gulf Coast Research Laboratory, Ocean Springs, Mississippi.*

THE FUNCTIONS OF THE AIR SAC IN SNAKES.—The lung of most snakes extends the greater length of the body, occupying from one-half to three-fourth of the visceral cavity (see drawings in Cope, 1900, Ann. Rep. U.S. Nat. Mus., 1898: 153-1270). The anterior portion is thick-walled and highly vascular; the inner surface has the appearance of a thick, slightly raised net. The posterior half to two-thirds of the total length is thin-walled, poorly supplied with blood, and is often called the "air sac." Its functions apparently have not been established, but there are several reasonable possibilities of perhaps equal importance; they include aids for (1) respiration; (2) evaporative cooling; (3) cooling of the reproductive organs; and (4) support of body. These possible functions are discussed in the following paragraphs.

The air sac may well serve as a "storage" area for inspired air. Upon inhalation it would allow air to pass over the vasculated portion, flowing posteriorly to the air sac, and returning past the vascularized portion. This dual exposure of air over the vascular area would increase the opportunity of exchange of gases. The method of breathing in snakes (Randall, *et al.,* 1944 Copeia: 136-144) tends to support this supposition. A snake inhales, holds its breath, and then expels the air with a series of short exhalations. The air sac would thus perform a function similar to the air sac of birds, the mechanics of which allow for a repassage of air over vascular areas.

The role of panting as a means of cooling by evaporation of moisture from the lungs and lining of the mouth is a well known phenomenon in birds and mammals (see, for example, Bartholomew *et al.,* 1953, Physiol. Zool., 26: 162-166; *ibid,* Ecology, 34: 554-560; B. and K. Schmidt-Nielsen, 1950). During times of heat stress snakes and lizards pant, apparently also for purposes of evaporative cooling (Bogert and Cowles, 1947, Ame. Mus. Nov. 1358: 1-34 Brattstrom, MS.). An accessory sac area of the lung would be of advantage in increasing the area for moisture loss for evaporative cooling.

The lethal effect of high temperatures on sperm production is well known. Heat-inducted sterility has been shown to be a possible reason for the descent of the testes in mammals. Cowles and Nordstrom (1946, Science, 104: 586-7) have suggested that the air sacs of birds (which surround the testes) serve a function analogous to the scrotum in mammals: *i.e.,* to maintain the testes at a temperaure below that of the body and hence below the lethal temperature for sperm producion. The air sac of male snakes extends to the middle of, or just posterior to, the testes. If cool air is inspired, it may serve to reduce the temperature of the area around the testes. A snake, being an ectotherm, absorbs its body heat by conduction from the ground and absorption of solar radiation. The dorsal surface and subsurface (testes area) regions of a snake might be expected

to be warmer than its general body temperatures, and thus reach temperatures higher than permissible to the physiology of the sperm. Normal inspired air would be expected to be of lower temperature than dorsal muscle temperatures.

The body of a snake is largely supported by the filled or partly filled lung and air sac. As a sternum is absent, the ribs of snakes are free ventrally except for their union with the skin. It was thought possible that if the air were removed from the lung and air sac of a snake, the ribs might bend posterodorsad and the body of the snake would have nothing to support it. To test this idea a glass canula, inserted into the glottis of an anesthetized red diamondback rattlesnake, *Crotalus ruber,* was connected to a vacuum to withdraw all the residual air from the lung. The snake, then extended on the table, was extremely flattened: in fact, the ventral surface of the vertebral column appeared to be almost in contact with the ventral body wall. The normal anesthetized snake was not flattened, the residual air serving to support the body. The air sac also undoubtedly is of supportive function in water, acting as a buoy.—*Bayard H. Brattstrom, Adelphi Coll., Garden City, Long Island, N.Y.*

AN ALTITUDE RECORD FOR *CONTIA TENUIS*.—On Sept. 6, '57 two *Contia tenuis* were found about two feet apart and about four inches within a moist log just south of the Fresno Co. line in Tulare Co., on highway 180 in Kings Canyon Natl. Park, Cal. The log was beside a stream; vegetation trees and ferns; the ground covered with decaying vegetation; temperature 59 F. and the humidity low. The U.S. topographical map indicates that the elevation is about 6,300 feet at this point; 1000 feet higher than recorded for this species by Robert C. Stebbins, (Amph. and Reptiles of Western N.A., McGraw-Hill, N.Y., p. 316).

One snake measured 32 cm. the other 29, total length. *Ensatina eschscholtzii platensis* was found feeding on small insects in the same log.—*Robert Wesley Harris, Dept. Zool., Univ. So. Cal.*

INTERORDERAL AMPLEXUS.—On Mar. 21, '59, a male *Rana pretiosa* was found in amplexus with a male *Ambystoma tigrinum* in a shallow recess under a small rotten bush two feet from the edge of a small pond 8 mi. E. Moscow, Latah Co., Idaho, one half mile from the Moscow-Troy highway. The temperature was 34 F. and a cold rain was falling. The frog was 65 mm. s-v, and the salamander 105. Sex was determined by dissection. The testes of the salamander were 17 x 3; those of the spotted frog, 6 x 2. The amphibians retained their positions for three hours, the frog above, clasping the salamander just behind the forelimbs. It is presumed that the amplexus took place in the water and that the salamander crawled into the recess where found.—*Carl D. Corbit and Larry Nelson, Dept. Biol., Univ. Idaho, Moscow.*

A NEW BLIND SNAKE (GENUS *TYPHLOPS*) FROM CUBA

By JOHN M. LEGLER

In December, 1958, Major Chapman Grant asked me to study 16 specimens of *Typhlops* (now catalogued in the University of Kansas Museum of Natural History) collected by him at Banes, Cuba, in 1956. Thirteen (KU 47456-68), ranging in total length from 76 to 161 mm. are typical *lumbricalis* and have dorsal scale-counts (240 to 280) that fall within or close to the range (255 to 285)indicated by Cochran (1924, Jour. Wash. Acad. Sci., 14(8): 174-177) for that species from eastern Cuba. The three remaining are of a previously unrecognized species that is named and described below.

Typhlops silus new species

Holotype: KU 47469, alcoholic, (Fig. 1); Banes, Oriente Province, Cuba; April, 1956; collected by Major Chapman Grant.

Paratypes: KU 47470-1, alcoholic; same data as holotype.

Diagnosis: A small snake of the genus *Typhlops* having: 1) 20 longitudinal rows of scales on anterior third of body, 18 to 20 at midbody, and 18 on posterior third of body; 2) 254 to 261 dorsal scales; 3) truncated, slightly trilobate snout; 4) complete or incomplete internasal suture; 5) generally pale dorsal coloration with few or no contrasting darker markings.

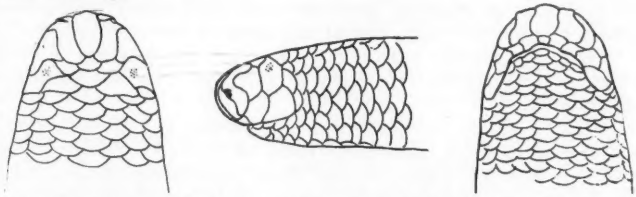

Fig. 1. Dorsal, ventral and lateral views of holotype of *Typhlops silus*, new species, approximately 4½ times natural size.

Description of species: Total length 85 to 126 mm.; length of tail one and one half to two mm.; diameter greatest at midbody, two and one half to four mm.; greatest diameter of body contained 30 to 34 times in total length; dorsal scales (from rostral to terminal spine) 254 to 261; spine on tip of tail conical; 20 longitudinal rows of scales on anterior third of body, 18 to 20 at midbody, and 18 on posterior third of body; four infralabials; four supralabials, first smallest, third and fourth largest and subequal; first supralabials flanking a smaller azygous scale immediately below rostral; rostral extending from azygous supralabial to point on top of head between eyes or between anterior borders of oculars; rostral narrowed where it passes over front of snout, part visible in ventral view slightly narrower than part visible in dorsal view; rear edge of rostral rounded, slightly tapered; eye easily discernible beneath translucent ocular scale; diameter of eye approximately one half greatest width of ocular; a large preocular on each side, its lower border in contact only

with third supralabial; ocular bordered above by supraocular anteriorly and by a large parietal posteriorly; supraocular slightly smaller than unmodified dorsals; parietal one and one half to two times size of unmodified dorsals; posterior edge of ocular bordered by two unmodified body scales; lower edge of ocular in contact with third and fourth supralabials; nasals essentially separated into anterior and posterior parts, but upper part of internasal suture complete or incomplete; posterior nasal larger and extending onto top of snout between preocular and rostral, in contact with supraocular; posterior ends of posterior nasals narrowly separated by first dorsal scale, not enclosing rostral; when internasal suture is complete or nearly complete (as in holotype) anterior nasal projects over posterior nasal forming sharp ridge from lower anterior border of nostril to point where suture meets rostral; aforementioned ridge appears as lateral extension of snout in dorsal and ventral views; anterior nasal in contact with second and third supralabials; snout broad and truncated (not evenly rounded or tapered); nasorostral sutures in form of sulci, giving snout inflated, slightly trilobate appearance in dorsal and ventral views; anteriormost parts of anterior nasals extending as far or farther forward than anteriormost part of rostral (paratypes).

Color of dorsum pale buffy brown to brownish gray; each dorsal scale having center slightly darker than edges, the contrast being greatest on anterior third of body but nowhere sharp; upper anterior part of snout cream; dim buffy markings (same color as dorsum) on posterior nasals, preoculars, and rostral; eye visible as dark spot; venter uniformly cream. Color of dorsum blending gradually with paler venter approximately midway up side of body; color of tail same as body.

Range: Known only from the type locality. The discovery of *T. silus* brings to 12 the number of species of *Typhlops* known to occur in the Antillean region.

Relationships: In characters of bodily scalation and proportions, *silus* most closely resembles *lumbricalis.* These two species occur sympatrically in Oriente Province, Cuba. *T. silus* differ from *lumbricalis* in having a truncated, slightly trilobate snout (snout evenly rounded in *lumbricalis*) and paler dorsal coloration. *T. silus* and *sulcatus* are alike in that both have trilobate snouts and variable internasal sutures; the two are distinguished chiefly on the basis of widely different numbers of dorsals (254 to 261 in *silus,* 397 in *sulcatus*), and different arrangement of longitudinal scale-rows (reduced posteriorly to 18 in *silus,* 20 throughout body in *sulcatus*). *T. sulcatus* has a more slender, more nearly tapered snout than does *silus;* in *sulcatus* the rostral projects well forward of the anterior nasals, whereas in *silus* the anteriormost part of the rostral is even with, or but slightly anterior to, the anterior nasals (more evident in paratypes than in holotype). Examination of the holotype of *sulcatus* reveals that the inernasal suture is complete on the left side and incomplete on the right; it is probably because of this bilateral variation that both sutures have been termed either complete or incomplete by other workers who have examined the specimen. I see no reason to question the validity of *sulcatus* until its characteristics are shown to fall within the range of variation of another known species of *Typhlops.*

Specimens examined.—Three (holotype and two paratypes), KU 47469-71.

Table 1. Counts of scales, measurements in mm., and other data pertaining to holotype and paratypes of *Typhlops silus* new species. In columns five and six the symbols + and − denote complete and incomplete internasal sutures, respectively.

	Dorsal Scales	Longitudinal scale-rows Ant.	Mid.	Post.	Internasal Suture Rt.	Left	Total Length	Diameter at Midbody
KU 47469	254	20	20	18	+	−	126	4.0
KU 47470	261	20	18	18	−	−	114	3.8
KU 47471	254	20	20	18	+	−	85	2.5

Species of Typhlops in the Antillean Region

Different species of *Typhlops* occur sympatrically (at least in a geographical sense) on three of the four largest Antillean islands; *lumbricalis* and *silus* occur on Cuba; *lumbricalis* and *pusillus* on Hispaniola; and *granti, platycephalus,* and *rostellatus* on Puerto Rico (*granti* and *platycephalus* occur together also on Muertos Island [Caja de Muertos] off the south-central coast of Puerto Rico). *T. jamaicensis* is the only species known to occur on Jamaica. Reckoning of the relationships of the Antillean species of *Typhlops* is difficult because of their resemblance to one another. Whether these resemblances (seen chiefly in external characters—scalation and body proportions) are the result of close relationship or of parallel evolution remain to be demonstrated. *T. jamaicensis, platycephalus* and *richardi* seem to constitute a natural group of closely related, yet definable, allopatric species, resembling one another in having relatively high numbers of scale-rows, straight-sided heads, and bicolored bodies. *T. monensis,* in spite of its lower number of scale-rows and paler coloration, seems also to belong in this group. These four populations may be members of a single polytypic species (*jamaicensis*). Although the affinities of *dominicana* are far from clear, it may constitute the southeasternmost population of the *jamaicensis* group. Close relationship, suggesting conspecificity, is seen also in the resemblance of *pusillus* to *rostellatus;* both have relatively low numbers of scale-rows, nearly uniformly colored bodies and pale blotches on tail and throat. The affinities of *lumbricalis,* the Antillean species having the widest geographic distribution, are not clear; conspecificity with the *rostellatus* group must be ruled out on the basis of geographic sympatry of *lumbricalis* and *pusillus* in Hispaniola. *T. granti, silus* and *sulcatus* seem not to be more closely related to any one of the known species than to others, and are not closely related to each other (unless the similarity of the snouts of *silus* and *sulcatus* indicates such a relationship).

In the present study I had opportunity to examine specimens of all but one (*tenuis*) of the species of *Typhlops* known to occur in the Antillean region. Descriptions of the Antillean species are scattered in the literature and are inconsistent as regards definition of scalation, bodily proportions and coloration. I take this opportunity to summarize certain definitive characters of these species (Table 2) and to present what I believe to be a workable, diagnostic key. Dichotomies that necessitated the counting of dorsal scales in order to identify a species were avoided wherever possible; however, dorsal scales (from rostral to tip of tail), as well as scale rows, were counted on nearly all of the 115 speci-

Table 2. Summary of known range of variation in characters of scalation and bodily proportions in Antillean *Typhlops*. Condition of internasal sutures is indicated as in Table 1; where ± is used, the suture is either complete or incomplete in that species.

Species and Original Description	Dorsal Scales	Longitudinal Scale-rows Ant.	Mid.	Post.	Total length ÷ Diameter at Midbody	Inter-nasal Suture
(Rep. U.S. Nat. Mus., 1902:687)	390-448	24	22-24	22	34-49	+
T. granti Ruthven and Gaige, 1935 (Occ. Pap. Mus. Zool. Univ. Michigan, 307:2, Fig. 1)	370-386	18	16 -	16	53-55	+
T. jamaicensis (Shaw), 1802 (Gen. Zool., 3(2):588, Pl. 133)	373-436	22	22 -	22	29-45	+
T. lumbricalis (Linnaeus), 1758 (Syst. Nat., 10th ed., 1:288)	240-320	20	18-20	18	25-41	+
T. monensis Schmidt, 1926 (Publ. Field Mus. Nat. Hist., Zool., 12:157, Fig. 1)	299-339	20	18-20	18	32-39	+
T. platycephalus Duméril and Bibron, 1844 (Erp. Gén., 6:293)	335-405	22-24*	20-22	18-20	32-45	+
T. pusillus Barbour, 1914 (Mem. Mus. Comp. Zool., 44(2):323, 1 Fig.)	270-292	20-22*	18-20	18-20	30-35	+
T. richardi Duméril and Bibron, 1844 (Erp. Gén., 6:290)	306-369	22*	20-22	18-20	34-43	+
T. rostellatus Stejneger, 1904 (Rep. U.S. Nat. Mus., 1902:686, Figs. 145-7)	321-353	20**	18-20	18-20	32-51	+
T. silus new species	254-261	20*	18-20	18	30-34	±
T. sulcatus Cope, 1868 (Proc. Acad. Nat. Sci., Philadelphia, 1868:128)	397	20	20	20	42 -	±
T. tenuis Salvin, 1860 (Proc. Zool. Soc. London, 1860:454)	395-425	18	18	18	49-59	+

*Scale-rows always fewer posteriorly than anteriorly.

**Seven of 78 specimens of *rostellatus* examined by Ruthven and Gaige (1935:Occas. Papers Mus. Zool., Univ. Mich., 307:1-12) had 20 scale-rows on anterior, middle, and posterior parts of the body.

mens examined. Counting of scales was facilitated by using scales marked with a white pencil as points of reference.

T. tenuis is included in the key and in Table 2 solely on the basis of Rosén's record (1911 Lunds Univ. Arsskr., N.F., ser 2, 7(5): 37) of a specimen (Zoological Museum, University of Lund) from Mastic Point, Andros, Bahamas. Rosén stated (*loc. cit.*) that the specimen agreed ". . . in all characters with *T. tenuis* . . ." except in having 22 longitudinal scale-rows (no indication given as to part of body on which count was made). The status of the population on Andros cannot be decided until Rosén's specimen is examined; in view of its high number of scale-rows (six more than in known specimens of *tenuis*) it seems unlikely that the specimen represents *tenuis*.

Inclusion of the Bahamas in the range of *lumbricalis* is based on Rosén's records (*loc. cit.*) for Andros and New Providence (one specimen from each) and on a single specimen in the (USNM 14579) from Abaco, of which Stejneger (1905 Geog. Soc. Baltimore, spec. publ.: 329-343.) "It deviates slightly from the general type which is found in nearly all the West Indian islands, but whether it represents a depauperate form of this species or only an individual aberration cannot be determined from a single specimen." I find the Abaco specimen to differ from Cuban *lumbricalis* before me in being paler (probably because of prolonged preservation) and in having a right preocular that is divided horizontally near the level of the eye. The specimen has a scale-row formula of 20-18-18, 256 dorsal scales, and is 148 mm. long; these three characters fall within the known range of variation for *lumbricalis*.

Vertebrae: Counts of vertebrae were made from roentgenograms taken of a few specimens of each species examined. Number of vertebrae (from axis to last caudal vertebra) in these specimens is; (number of specimens and locality from which obtained are given in parentheses): *dominicana,* 226-231 (3, Guadeloupe); *granti,* 240-245 (2 paratypes, Caja de Muertos and Puerto Rico); *jamaicensis,* 226-234 (3, Jamaica): *lumbricalis,* 162-166 (4, Banes, Cuba); *lumbricalis,* 173 (1, Abaco); *monensis,* 208-213 (4, Mona); *platycephalus,* 220-233 (4, Puerto Rico); *pusillus,* 159-172 (4, Hispaniola); *richardi,* 197-205 (4, St. Thomas); *rostellatus,* 194-197 (4, Puerto Rico); *silus,* 163-166 (3, holotype and paratypes); and *sulcatus,* 216 (1, holotype).

Remarks: One specimen of *Typhlops* (UMMZ 76626—one of two specimens bearing this number), obtained 10 km. south of Canovenas, Puerto Rico, by Grant 1931, merits special mention in that it differs from known Puerto Rican species. It is briefly described as follows: body pale gray, venter slightly paler than dorsum; a distinct cream blotch on under surface of tail; another, smaller, cream blotch on throat; nasorostral sutures in form of deep sulci; snout blunt, trilobate; anterior tip of rostral nearly even with anterior tips of anterior nasals; rostral narrow above (approximately same width as upper part of posterior nasal), straight-sided, slightly tapered below; internasal sutures incomplete; scale-row formula 20-18-18: dorsal scales 335; vertebrae 195; total length 204 mm.; diameter at midbody 6.6 mm.; diameter contained in length 31 times. The trilobate snout and incomplete internasal sutures of UMMZ 76626 distinguish it from the three species (*granti, platycephalus* and *rostellatus*) known to occur in Puerto Rico and suggest relationship to

silus and *sulcatus*. The pale blotches on tail and throat, the nearly uniform coloration, the scale-row formula, and the number of dorsal scales fall within the range of variation known for *rostellatus;* several typical examples of *rostellatus* were obtained from the same locality. A decision as to whether UMMZ 76626 is an anomalous specimen of *rostellatus* or a representative of an unnamed taxon cannot be made on the basis of specimens now available.

One female of *jamaicensis* (USNM 102661) is preserved with three leathery-shelled eggs; the eggs are 22 to 25 mm. long and nine to 10 wide. Three other eggs of approximately the same size are in the body.

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Comparative materials (total of 115 specimens examined).—*dominicana* (five from Guadeloupe): USNM 11089, 11169-70, 11237, 11382; *granti* (two paratypes): UMMZ 76670, Caja de Muertos; UMMZ 76671, 1 mi. W. Parguera, Puerto Rico; *jamaicensis* (nine from Jamaica): USNM 12378 (2), 42882, 73261, 77023, 102661, 108280-1, 108529; *lumbricalis* (41): KU 47456-68; USNM 12357 (5), 27647, 31162, 36813, 51863, 54406, 56295-301, 63216, 101061, 103623-5, 134358-61, Cuba; USNM 14579, Abaco, Bahamas; *monensis* (seven from Mona): UMMZ 76637 (6), 76638; *platycephalus* (10 from Puerto Rico): USNM 25779, 27324, 27489, 29198, 29364, 30908, 120799-800; UMMZ 76655(2); *pusillus* (seven from Hispaniola): USNM 64271, 74944, 74980, Dominican Republic; USNM 69441, 76649, 123983, 140242, Haiti; *richardi* (nine from St. Thomas): USNM 12014 (4), 66521, 98964-5, 115829-30; *rostellatus* (20 from Puerto Rico): UMMZ 76623, 76626, 76627(2), 76628-31, 76633(6), 76636(5), 90165; *silus* (holotype and two paratypes): KU 47469-71, Banes, Oriente Province, Cuba; *sulcatus* (holotype): USNM 12371, Navassa; *Typhlops* sp.: UMMZ 76626, 10 km. S Canovenas, Puerto Rico.

*Key to Antillean species of *Typhlops*

1. Maximum number of longitudinal scale-rows (anterior one third of body) more than 20 2
> Maximum number of longitudinal scale-rows 20 or fewer 5
2. Number of scale-rows the same (22) on anterior, middle, and posterior parts of body; body sharply bicolored, pale yellow of venter encroaches slightly on brown of dorsum, creating a jagged line where two colors meet on side—Jamaica ..... *jamaicensis*
   Number of scale-rows fewer on posterior than on anterior part of body; body bicolored or not 3
3. Scale-rows 24 anteriorly, reduced to 22 posteriorly; general color dirty cream to grayish brown in preserved specimens, venter only slightly paler than dorsum; tail not noticeably bicolored—Dominica and Guadeloupe ..... *dominicana*
   Scale rows 22 anteriorly (rarely 24)[1], reduced to 18 or 20 posteriorly; body brown above, yellowish cream below, at least in well-preserved adults 4

[See correction, vol. 16, p. 72]

4. Head flattened, depressed; profile of snout wedgelike; yellowish color of ventral surface of tail extends at least part way onto dorsal surface, forming yellow ring around tail of some specimens; dorsal scales more than 350 in 97 per cent of specimens (average, 378)—Puerto Rico, Vieques, Culebra, Caja de Muertos, Caja Luis Pena ..... *platycephalus*
Head not especially flattened or depressed; profile of snout evenly rounded; yellowish color of tail confined to ventral surface, not extending up on sides; dorsal scales fewer than 350 in 92 per cent of specimens (average, 337)—St. Thomas, St. John, and Tortola ..... *richardi*

5. Maximum number of scale-rows 18 6
Maximum number of scale rows 20 7

6. Scale-rows 18 on anterior, middle, and posterior parts of body; preocular in contact with second and third supralabials—Andros Island ..... *tenuis*
Scale-rows reduced to 16 on posterior part of body; preocular in contact only with third supralabial[2]—Puerto Rico and Caja de Muertos ..... *granti*

7. Nasorostral sutures in form of deep sulci; nasal and rostral scales having inflated appearance; snout squarish and/or slightly trilobate in dorsal and ventral views 11
Snout evenly rounded or slightly pointed, not trilobate, not deeply sulcated, and not squarish 8

8. Snout pointed in dorsal view, elongate; top of head flattened or depressed; eye beneath anterior part of ocular, anterior edge of eye touching or nearly touching ocular-preocular suture—Mona ..... *monensis*
Snout blunt, evenly rounded in dorsal view; head not flattened or depressed; eye more nearly beneath center of ocular, never touching ocular-preocular suture 9

9. Two preoculars—Hispaniola ..... *pusillus*
One preocular 10

10. Body much paler below that above; under surface of tail same color as belly, lacking a distinct, paler blotch; no pale blotch on throat; third scale in dorsal row usually wider than second, always wider than first—Bahamas: Abaco, Andros, New Providence; Cuba; Hispaniola ..... *lumbricalis*
Body nearly uniform dark brown, only slightly paler below than above; a pale cream blotch, contrasting sharply with darker color of belly, on under surface of tail; a smaller pale blotch on throat of many specimens; first, second, and third scales in dorsal row subequal in width, the third narrower than the first (never wider) in some specimens—Puerto Rico ..... *rostellatus*

11. Scale-rows 20 on anterior, middle, and posterior parts of body; dorsal scales more than 300—Navassa ..... *sulcatus*
Scale-rows reduced to 18 posteriorly; dorsal scales fewer than 300—Oriente Province, Cuba ..... *silus*

[1]Four of 64 Puerto Rican *platycephalus* examined by Ruthven and Gaige (1935:7) had 24 scale-rows; one anomolous specimen had 20 scale-rows.

[2]An illustration by Ruthven and Gaige (*op. cit.*: 3, Fig. 1) shows one of the paratypes of *granti* (UMMZ 76671) to have the left preocular in

contact with the second and third supralabials; examination of this specimen shows the preocular to be in contact only with the third supralabial, as is true of the one other paratype that I have examined (UMMZ 76670), the holotype, and presumably the two remaining paratypes.

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NOTES ON THE SNAKE *LEPTOTYPHLOPS COLUMBI* KLAUBER.—Klauber, in his description of *Leptotyphlops columbi* from Watlings Island, Bahamas (1939, Trans. San Diego Soc. Nat. Hist., 9 (14): 62-64, figs. 3a and 3b), pointed out that specimens of this species from the Bahamas had been referred by other authors to the closely related *L. albifrons*. Klauber referred to the papers of Werner (1917, Mitt. Zool. Mus. Hamburg, 34:203) and Barbour (1930, Zoologica, 11 (4): 107; 1935, *Ibid,* 19 (3): 130; and, 1937, Bull. Mus. Comp. Zool., 82 (2): 149), which reported *L. albifrons* as occurring on Watlings Island, Grenada, Antigua and Swan Island, but listed no specimens and gave no data on variation. To the best of my knowledge no account, other than that of Klauber (*loc. cit.*), of the species *columbi* has appeared.

Four specimens of *columbi* from the type locality, discovered in the collections of the U. S. National Museum (USNM 14578 a to d) and examined through the courtesy of Dr. Doris M. Cochran, provide additional information on variation in the species. Counts of scales and appropriate measurements (in millimeters) are given in the following table along with the combined data for the type and four paratypes reported by Klauber.

	Dorsal scales	*Sub-caudal scales*	*Total length*	*Tail length*	*Total length / Tail length*
Type and paratypes	255-263	24-25	124-148	10.5-12	11.8-12.9
USNM 14578 a	265	23	156	12	13.0
USNM 14578 b	252	22	138	11	12.6
USNM 14578 c	249	23	138	11	12.6
USNM 14578 d	242	24	119	9	13.2

Although the specimens are probably somewhat faded, they seem to differ slightly in coloration from those described by Klauber. The dorsal scales are medium to light brown and are distinctly edged with a paler color; no distinct lines are formed by the dark portions of the scales except for a mere suggestion of a dark line on the fourth lateral scale-rows on the anterior part of the body. All the specimens are much paler ventrally than dorsally, the contrast between these colors being fairly sharp on the anterior part of the body in the three smaller specimens. Two of the specimens (b and d) have a faintly defined pale mark in the parieto-occipital region. The terminal spine of all four is laterally compressed and sharp-edged dorsally and posteriorly. Other than the characteristics mentioned above, the specimens agree with the description given by Klauber.—*John M. Legler, Museum of Natural History, University of Kansas, Lawrence, Kansas.*